

The Greening of Industry: An Ecological Economic Appraisal of Eco-innovations and Eco-labelling

S. Salman Hussain

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Declaration

I hereby declare that this thesis has been composed by myself; that the work is my own; and that the work has not been submitted for any other degree or professional qualification.

Date

S. Salman Hussain

Abstract

In a market economy, the behaviour of firms determines the extent and type of anthropogenic impacts that affect natural ecosystems. As such it is critical that the regulation of corporate behaviour is closely appraised. All economic production systems use natural resource inputs and release waste emissions to environmental sinks; they also contribute to sustainability in terms of income generation. The analysis of economic efficiency is thus coined in terms of juxtaposing and balancing these effects and the role of regulation is to intervene so that the outcome (in terms of corporate behaviour) approximates to this theoretical social optimum. Determining optimal regulation is the core focus of this thesis. The role of environmental regulation has become prominent of late owing to developments in the science (and social science) of climate change and ecosystems functioning. It has also been strongly influenced by the Porter Hypothesis (PH) which challenges the non-interventionist doctrine of neo-classical economics in favour of stricter environmental regulation, based on the presumption that significant pollution offsets are available if and only firms are forced to search for eco-innovations. In order to progress the argument vis-à-vis optimal regulation it is first essential to explore the role of the firm in society, i.e. what the responsibilities of industry *ought to be* with respect to the sustainability agenda. I juxtapose and critically appraise functionalist theory and its associated utilitarian ethic with social permission theory; the outcome of this analysis is the contention that 'I&We' deontological theory is the most defensible alternative and as such a firm's fiduciaries ought to balance the conflicting claims of stakeholders, i.e. shareholders are important but not paramount. Given this outcome, the role of the regulator is to intervene when the market for 'green' corporate behaviour does not function. There are various reasons outlined as to why such intervention might be required. On the demand side, evidence is presented of consumers' willingness-to-pay for perceived environmental quality. This product attribute is typically a credence attribute and there is asymmetric information; there is an incentive for 'greenwashing', i.e. false or misleading environmental marketing claims. The strategic behavioural model developed herein implies that the *status quo* is potential sub-optimality in that consumers play a mixed strategy and, over time, there is the potential for a vicious cycle in that progressively less and less 'green' marketing claims are genuine. On the supply side, firms may be 'satisficing' as opposed to optimising with respect to eco-innovations; a firm's search for and selection of innovation is path-dependent, i.e. the history of innovations is influential. This supports the PH in that stimulating a shift to an eco-innovation trajectory realises benefits not only in the current time period but into the future. I also demonstrate that firms may be 'locked in' to technological paths that are sub-optimal (and environmentally damaging) owing to 'coordination effects' and as such there is a further role

for economically efficient regulatory intervention on the supply side. Well-designed regulation can improve economic welfare in that it might propagate a shift in (as opposed to movement along) abatement cost curves. This in turn implies a convergence between the ‘best’ level of pollution for the polluter and for society, therein ameliorating the potential deadweight losses from the strategic interaction between the polluter and the regulator.

Key words

Porter; regulation; corporate; responsibility; lock-in; evolutionary; eco-labelling; efficiency.

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List of Abbreviations

AHP	Analytical Hierarchy Process
CEF	Corporate Ecological Footprinting
CERES	Coalition of Environmentally Responsible Economies
CGS	Corporate Genuine Savings
CSR	Corporate Social Responsibility
DEA	Data Envelopment Analysis
EF	Ecological Footprint
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management System
gHa	Global Hectare
GRI	Global Reporting Initiative
HK	Human Capital
IPC	Innovation Possibility Curve
IUCN	International Union for Conservation of Nature and Natural Resources
LCA	Life Cycle Assessment
MAC	Marginal Abatement Cost
MEC	Marginal External Cost
MK	Manmade Capital
NC	Neo-Classical
NK	Natural Capital
OECD	Organisation for Economic Cooperation and Development
PPP	Polluter Pays Principle
PH	Porter Hypothesis
SME	Small to Medium-sized Enterprise
SVA	Sustainable Value Added
TNC	Trans-National Corporation
VOC	Volatile Organic Compound
WCED	World Commission on Environment and Development
WBCSD	World Business Council for Sustainable Development
WTO	World Trade Organisation

1 INTRODUCTION

This thesis is concerned with the application of economic principles to environmental management in business. Environmental management is an applied discipline that investigates modifications to business practice that are stimulated by society's concern for the impact of industrial processes on the natural environment. The 'greening' of industry (or corporate 'eco-change') might be defined as the sum of these various modifications in corporate decision-making. 'Operationalising' the paradigm of sustainable development takes these modifications a step further to include social values and inter-generational equity. Sustainable development has been famously defined by the World Commission on Environment and Development [WCED] (the 'Brundtland Commission): "development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987:43). Although there is a burgeoning literature on corporate environmental management there has been comparatively little research into the *economic efficiency* of this eco-change process. In other words, whereas environmental management answers the question of how the firm should best respond to the market, this research answers two key questions:

1. What level of corporate eco-change is socially optimal in economic terms?
2. What forms of regulatory intervention in the market can be justified in economic efficiency terms so as to stimulate this level of eco-change?

Another way of coining the core research question is to ask whether the *status quo* in terms of the regulation of the industry/ecology interface is maximising welfare in society. These are 'big' questions that are multi-dimensional in nature.

The questions are also broadly *conceptual* in nature and as such, notwithstanding the three studies that are documented, the advancement of the state of knowledge herein is more theoretical than empirical. Although two of the three case studies are surveys of the same industry (the chemicals industry) it is not my intention to supply a sustainability prognosis *per se* for the chemicals industry but to determine whether the empirical evidence supports the theories developed in general. The reason that the thesis is balanced more towards the theoretical than the empirical arises from one of the key foci that insinuates into the entire thesis, *viz.* choice under conditions of asymmetric information. There are three agents in my appraisal of the greening of industry: firms, consumers and the state regulator. The asymmetric condition that I assume to apply is that, in general, firms are better informed of the extent of the environmental impact of their production systems than either consumers or the state. Under this assumption there are instances of potential market failure in light of which regulatory intervention might be economically efficient. These theoretical expositions (*cf.* Chapters 5 and

8) cannot be directly empirically tested as firms that are intentionally duping the regulator and/or the consumer by definition will not openly reveal this behaviour (as the associated private benefits to the firms would then no longer persist). Thus both the extent of and the rationale for such firm behaviour cannot be empirically tested.

The aim of this short introductory chapter is to chart the structure of this thesis with respect to the goal of answering these ‘big’ conceptual questions. It is perhaps useful to state categorically the objectives of this research which, if achieved, should provide responses to these questions:

- Objective 1* Define the role of the firm in society vis-à-vis the sustainability agenda in conceptual terms, i.e. what the rights and responsibilities of firms *should* be and, given this, what is the role of the state?
- Objective 2* Outline and critique methods to measure corporate sustainability, i.e. determine whether we can reliably chart progress in terms of what they are *actually doing* in terms of delivering corporate sustainability
- Objective 3* Outline and re-conceptualise the *extant arguments* for regulatory intervention given the *status quo* vis-à-vis corporate sustainability
- Objective 4* Set out the conditions that determine the *supply* of corporate sustainability, i.e. the adoption of eco-innovations
- Objective 5* Determine the behaviour of consumers in terms of the *demand* for corporate sustainability, in the form of purchases of eco-labelled products
- Objective 6* Outline instances where the outcomes of the research point to the potential for the *status quo* vis-à-vis corporate sustainability to be adjudged economically inefficient, i.e. where extant arguments for regulatory intervention might be modified

The structure of the thesis is set up to meet these objectives. Objective 6 is a reformulation of the aforementioned big questions and is met through Objectives 1-5. The specific ordering of the chapters in the thesis, a synopsis of their content and the link between their content and the objectives is provided below.

Chapters 2 and 3 are linked to Objective 1. Objective 1 appears on first inspection to be incongruous (or even superfluous) to the core discussion of optimal regulatory intervention as it is broadly an *ethical* discussion of the role of the firm in society. However I would argue that such an ethical discourse is essential. Policies are set by the state/regulator and therefore it is necessary to consider the underpinning assumptions concerning the regulator/firm interaction. Chapter 2 considers the following question: should a firm be duty-bound to improve social

welfare by taking into account all affected stakeholders in its decision-making, or should corporate social responsibility (CSR) begin and end with the firm simply staying within the confines set by legislation? There are two reasons why this question impinges on the regulation of corporate sustainability. First, if the regulator has an expectation that firms should act in accordance with CSR (as opposed to being simply responsive to evolving green market conditions) then this expectation must be justified, its ethical foundation elucidated. The reason is that the functionalist school (Levitt, 1983) contends that societal welfare is maximised by establishing strict demarcation between agents in society (including but not restricted to the firm and the state) and that CSR is a “a fundamentally subversive doctrine” (Friedman, 1963:133). This position is still of significant today and thus should be at the very least elucidated and critiqued as it impinges on the level of regulatory intervention that is desirable and the outcome that any regulation is intended to achieve. The second reason to pose this CSR versus responsiveness question is intra-firm behaviour, i.e. what rights and responsibilities do firms’ fiduciaries have? The rhetoric of the greening of industry literature is suffused with CSR didacticism and yet, if the functionalist argument is credible, attempts by fiduciaries to promote wittingly CSR outcomes, i.e. to respond to this didacticism, might be misguided.

Whereas Chapter 2 discusses how firms *should* behave vis-à-vis their impact on the environment and society at large, Chapter 3 presents a survey carried out to determine what firms’ fiduciaries themselves *perceive* their role to be. The methodology applied is analytical hierarchy process (AHP) which is ideally suited to this application in that respondents trade off one attribute against another, e.g. profitability against responsibility. The aim of this study is to select a sample of firms that have the following characteristics: (i) expended corporate resources on sustainability, *viz.* having an extant environmental management system (EMS); (ii) small-to-medium sized enterprise (SME); and (iii) located in one defined local community, *viz.* Dalkeith in Mid-Lothian, Scotland. These selection criteria mean that the firm arguably has a stronger local identity than a trans-national corporation (TNC) and that the respondents are less likely to apply corporate ‘spin’ to responses. As a consequence the respondents are relatively well placed to describe the trade-offs between conventional business concerns (profitability, cash-flow regulation *etc.*) and the factors that might propagate any sense of corporate duty (local sustainability concerns, broader environmental issues *etc.*). In terms of the objectives, Chapter 3 is again linked to Objective 1 but the survey is also concerned with the adoption of eco-innovations, i.e. Objective 4. Eco-innovations are defined herein as modifications to production practices that reduce their environmental and/or social impact.

Chapter 4 turns to Objective 2. It sketches the development of the sustainable development paradigm and its impact on the corporate mindset. As such it provides an overview of how

industry in general has *actually* behaved in practice and how the state has regulated this behaviour, i.e. the macro-level context for this research. This context-setting feeds into the appraisal of extant tools to *measure* corporate sustainability. This is clearly an important review for the purposes of this research: green consumerism (Chapter 8) depends on the availability of methods that allow impacts to be measured; and these impacts depend on the extent to which firms have adopted eco-innovations (Chapters 6 and 7).

Chapter 5 is principally concerned with Objective 3 but also is the first analysis that explicitly talks to Objective 6, i.e. developing arguments for modifying regulatory behaviour. The extant arguments for regulatory intervention are coined in terms of the Porter Hypothesis (PH) which proposes that stricter environmental legislation is socially optimal as firms do not realise the extent of the benefits that can arise from eco-innovation (Porter, 1991). The standard extant neo-classical (NC) argument for regulatory intervention (e.g. Edwards-Jones *et al.*, 2000) is the need to internalise pollution externalities, a form of market failure that arises as environmental quality is a public good. Chapter 5 does not simply restate this rudimentary analysis but instead coins it in terms of the PH as the latter has not only stimulated academic analyses but also high-level political credibility (e.g. Gore, 1992). I conceptualise the PH in terms of this conventional appraisal of marginal abatement cost (MAC) and marginal external cost (MEC) curves but with two propositions: (i) the MAC curve pertains to *extant* information set of the polluter/firm and market conditions; and (ii) the MAC curve represents costs of abatement *net of any benefits*. These propositions allow for the MAC curve to shift (if market conditions/information change) and for the firm to be on some segment of its MAC curve that implies that, were it to abate one marginal pollution unit, net profitability would rise, i.e. a ‘win-win’ outcome. This conceptualisation is useful for the purposes of the overall research in that the analysis of eco-innovation adoption (Chapters 6 and 7) implies that firms may be on some sub-optimal point on their respective MAC curves and that eco-labelling (Chapter 8) can stimulate a shift in the MAC curve. More generally, the PH proposes that pollution offsets from incentive-compatible stringent environmental legislation exceeds abatement costs. Chapter 5 sets out the necessary conditions for this proposition.

One aspect of the PH that has not to date been expounded is the convergence between the private and social pollution optima that arises from any inward shift in the MAC curve. As mentioned above, one of the themes that insinuates into this research is the implications of asymmetric information and choice of optimal pollution regulation under this condition. I set out in Chapter 5 modified conditions for the PH proposal that more stringent environmental regulation is economically efficient, *viz.* abatement costs must not exceed the sum of both

offsets *and* the expected decrease in welfare loss arising from this firm/regulator asymmetry. This is the contribution of Chapter 5 to Objective 6.

Chapters 6 and 7 turn to the *supply* of corporate sustainability in the form of theories of eco-innovation adoption (Chapter 6) and then testing these theories (Chapter 7); both chapters contribute to Objectives 4 and 6. In Chapter 6, the economics and organisational behavioural literatures are reviewed so as to describe firm behaviour towards eco-innovation and the adoption of eco-change at the firm level. The analysis is divided into an appraisal of the micro-level firm ‘search and selection’ of eco-innovations (Nelson and Winter, 1973) and systemic issues termed ‘network externalities’ (Arthur, 1989) that might influence the eco-innovation trajectory. The latter refers to firms being ‘locked into’ inefficient innovation trajectories. In both cases the analysis draws on the general literature on innovation theory and discusses its validity vis-à-vis eco-innovations.

The evolutionary economics perspective of the Nelson-Winter models describe a scenario wherein firms are not perched on their respective efficiency frontiers (Nelson and Winter, 1995) but instead search for innovation options if and only if profitability levels fall below some threshold. This search is conditioned by the extant innovation trajectory, i.e. the history of previous innovations matters. This is in contrast to the traditional NC economic perspective *viz.* firms efficiently select a profit-maximising production system irrespective of what they have done in the past; a competitive marketplace then ensures that those that fail to so select will be driven from the marketplace. This traditional worldview suggests there is no innovation path dependence *per se*. If the Nelson-Winter perspective is descriptive of the eco-innovation search then there are significant implications for regulatory intervention (Objective 6): in many industries firms have a relatively short history of searching for eco-innovations; and the factors that the Nelson-Winter models describe as influencing innovation searches (e.g. mimicking competitors) may not apply to eco-innovations. The Nelson-Winter models (and the evolutionary economics perspective in general) talk to the PH debate but this link has not previously been made to the author’s knowledge. Chapter 6 sets out these models of firm-level innovation alongside alternative perspectives. Chapter 7 tests the validity of the evolutionary perspective in the first of two surveys of sectors within the UK and German chemicals industry. The aim of the empirical study in Chapter 7 is to provide some insight into the *process* of eco-innovation adoption.

Whereas Chapters 6 and 7 focus on the supply of industrial sustainability, Chapter 8 turns to the demand side and therein refers to Objectives 5 and 6: it focuses on eco-labelling as a marketing tool. The core concept is that if eco-labelling functions properly then consumers who value the

product attribute of ‘environmental quality’ (or some sustainability attribute) can signal their preference by purchasing an alternative that has a high perceived content vis-à-vis this attribute (Hussain and Lim, 2000). As awareness and consumer responsiveness to environmental issues increases over time, so might green consumerism and the concomitant incentives for corporate eco-innovation adoption, potentially shifting the MAC curve (*cf.* Chapter 5). In Chapter 8, theories of green consumerism and the development of eco-labelling as a tool are set out and analysed as is the *status quo*, i.e. the co-existence of externally-accredited eco-label schemes and potential ‘greenwashing’, i.e. false or misleading environmental claims. A two agent (firm-consumer) strategic behavioural game is developed to consider the optimality of state intervention in the domain of eco-labelling. Again this refers to choice under conditions of asymmetric information and the conditions that would need to apply to make any regulatory intervention economically efficient. The latter segment of Chapter 8 reports the results of a survey also carried out in Germany and the UK in a different sector of the chemicals industry, *viz.* the coatings industry. This survey outlines the drivers towards participation or non-participation in eco-labelling schemes. The coatings sector was chosen for two reasons: first, it is a sub-division of the chemicals industry as is pharmaceuticals (*cf.* Chapter 7); second, eco-labelling schemes do exist in this sector. The outcomes of Chapter 8 are a discussion of the demand side for corporate sustainability (Objective 5) and reasons why the status quo might be modified in light of the theoretical exposition set out (Objective 6).

In Chapter 9, I return to the Objectives set out above and present overall conclusions.

2 THE CORPORATE SOCIAL RESPONSIBILITY DEBATE

2.1 Introduction

This chapter is modified from Hussain (1999). It concerns the philosophical debate underpinning any investigation of the greening of industry, i.e. the role of industry in society and CSR. It is a necessary and oft-neglected debate in that policy prescriptions and incentives/disincentives for industry to change behaviour are based on some assessment of the domains of 'managers', 'the firm' and 'the state', and the responsibilities of each to the other. Note that the ethics of the interaction *between* states is not considered here¹. The optimal regulatory framework is based on three elements. First, a socio-political decision on the level of intervention that is desirable by the regulator. Second, the vision of the idealised state/outcome that any regulation is intended to achieve. Third, the appraisal of the policies that are likely to be applicable in achieving this outcome and the relative merits/demerits of alternative states of nature that might arise, along with the probability of their arising. This chapter informs the first and second elements (which are interrelated) and thus provides an important foundation for policy evaluation.

There is a spectrum of potential responses by firms to the sustainability or greening agenda. In this chapter I critically appraise the conflicting ethical positions as to where firms *should* be on this spectrum. The context for this discussion is set out in Section 2.2. One end of the spectrum is the adoption of a highly 'reactionary' approach to environmental legislation, and managing the production process so as to maximise the single (assumed) objective of firm profitability; this is a utilitarian argument, discussed in Section 2.3. The other extreme on this spectrum is that of firms adopting a proactive leadership role in setting and pushing forward a radical agenda that shifts society away from consumerism and consumption; this argument stems from stakeholder management, discussed in Section 2.4. Section 2.5 provides a synopsis of the implications of the conflicting positions for the key agents in the greening agenda, i.e. firms fiduciary agents, firms themselves and the regulator. Section 2.6 provides chapter conclusions.

2.2 The greening of industry agenda

A significant proportion of authors of green business texts (e.g. Davis, 1991; Ledgerwood *et al*, 1993; North, 1992; Welford and Gouldson, 1993; Welford, 1995; Elkington, 1987) propose that managers should be the instigators and guardians of a societal change towards sustainable

¹ This research assumes that the state should act so as to maximise the welfare of its citizens and its citizens alone. (What exactly constitutes 'welfare' is discussed in Section 2.3.3.) Thus, the performance of the UK government is assumed not to be contingent upon the welfare of non-UK citizens. This 'selfish' behaviour by the state can imply a global 'tragedy of the commons' (Hardin, 1968); there is a large literature on the management of common pool resources given such 'selfish' behaviour, e.g. Ostrom *et al.*(1994).

development. There is the notion of managerial *duty* towards the environment. Davis (1991) is typical in this regard:

The radical change arising out of the moral choice to pursue a course of sustainable development must result in a change both in the shared values and in the vision of most commercial enterprises (Davis, 1991:29)

It is necessary to unpack the ethical 'baggage' of such a position so as to reveal its full implications. The NC school would propose that the notion of CSR is counter-productive: following the dictate of Davis (1991) would then *reduce* social welfare, although 'ethically-minded' managers had intended the exact opposite. A second reason for the unpacking is that there is a good deal of confusion and contradiction within the CSR school.

Consider for instance Welford (1995). Richard Welford is currently a leading exponent of eco-revolution and a highly influential author in the greening of industry literature, although he was arguably a contrite advocate of conventional profit-driven environmental management in his earlier publications (e.g. Welford and Gouldson, 1993). Welford endorses a view that is counter-capitalism in the sense that profits are deemed of less than paramount importance, although he does temper his position to some degree by stating that there is no inherent contradiction between radical corporate sustainability (which he states as being one that is not anthropocentric) and conventional business success:

[Managers] need to become aware that it may be necessary to sacrifice considerable short-term gains in order to secure long-term benefits. One difficulty that more progressive business managers face today in trying to shift to a longer-term approach is that it could place them at a temporary competitive disadvantage in relation to their more selfish business competitors who persist in a short-term approach. (Welford, 1995:125)

Welford (1995) goes on to states: "*as well as earning profits*, organisations today are expected to contribute to social welfare" [emphasis added] (Welford, 1995:127). The argument thus appears to swing from the denigration of the profit-motive as the driver for business to its reinstatement as an *expected* outcome. Further, the term 'selfish' as used to described competitors is somewhat loaded; is it indeed the case that sacrificing "considerable short-term gains" and by extension jeopardising the financial security of the firm (and all those who depend on it) is a selfless action that should be encouraged?

The eco-heroism of Welford (1995) is repeated elsewhere in the green business literature. Anita Roddick of the Body Shop states: "real moral burden...[rests on] the shoulders of industrial leaders who must now lobby for the greater good" (Roddick, 1992:73). Her argument assumes

that both politicians and voters apply a short-term perspective. Thus, if the environmental movement waits for both these groups “to be converted wholesale to environmentalism, we’ll be waiting for ages” (*ibid.*). The implication is that managers must adopt a proactive environmental agenda, since apparently nobody else will. Roddick’s position is disturbing, even though it might not appear contentious. In a democratic state, voters constitute society; these same voters also are consumers. The non-participation (or insufficient participation) of voters in the green agenda is established as the premise for managerial eco-heroism; but this premise implies that society has rejected environmentalism within the framework of choice offered by democracy. Thus, Roddick implies that corporate social responsibility is served by something akin to eco-anarchy.

The question that needs to be addressed is whether such managerial actions then increase or decrease social well-being, or how a firm potentially being driven closer to bankruptcy in following the Welford (1995) dictate changes social welfare. These are the types of questions that require an evaluation of the ethical foundations to managerial decision-making vis-à-vis sustainability and the natural environment. Sections 2.3 and 2.4 consider respectively NC and socio-economic positions within the corporate social responsibility debate.

2.3 Neo-classical Economics Contributions

The ethical foundation for NC economics is utilitarianism, wherein an action’s worth is defined in terms of the consequences that it has on total societal welfare. Since utilitarianism is a form of consequentialism, actions that might not be considered intrinsically ‘good’ can nevertheless be justified if they produce ‘good’ outcomes, i.e. social welfare rises. One application of this consequentialism is Adam Smith’s ‘invisible hand’ concept (Smith, 1966/1776), wherein self-interested profit-seeking behaviour increases societal welfare. An associated concept is the Fundamental Theorem of Welfare Economics: given certain specified assumptions², profit-maximising competitive equilibria correspond exactly to the achievement of a Pareto optimum. This Theorem implies that the role of the firm in society is solely to profit-maximise within the confines of the law; this ‘selfish’ private motivation then coincides with the maximisation of social welfare given the aforementioned assumptions. It is then appropriate to substitute corporate social *responsiveness* to changing conditions for corporate social *responsibility*: CSR then has no place in NC economics in general. If the best response (purely in terms of profitability) to changing conditions is, say, for a purchasing manager to buy green or fair trade alternatives, then the manager should select this alternative. This is a necessary and sufficient condition for such behaviour by the manager acting as a fiduciary agent to the firm. The

² These assumptions are: non-satiation; private ownership economy; only pure private goods; no monopoly power; no externalities apply. See Cowell (1986). The empirical validity of these assumptions is explored further in Section 2.3.1.

corollary is that if the manager expects profit-maximisation to be inconsistent with the greener choice then the choice is inappropriate both in terms of private firm-level welfare and social welfare.

It is noteworthy that the ethical context for the appraisal of managers' behaviour is their *expectations* concerning the outcome of any of their decisions vis-à-vis profitability. All business decisions are made under conditions of uncertainty and thus the level of accuracy of the fiduciaries' profit projections will only be revealed *ex post*. If fiduciaries systematically modify their projections so as to improve the likelihood of a socially/environmentally good option being selected then they are (through personal choice) violating the ethical principles of neo-classicism.

Figure 1 Schematic presentation of the neoclassical view of the firm in society (Hussain, 1999)

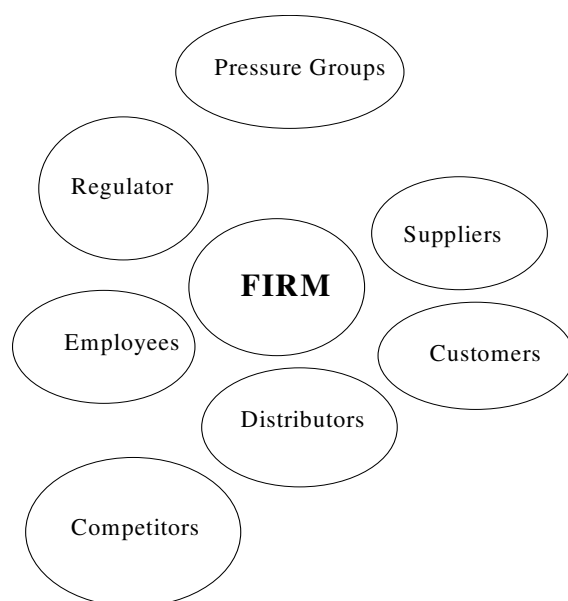


Figure 1 shows the firm and its relations with agents in the economy that are external to it in the NC worldview. It does depend on some of these agents, but functional theory proposes that society is best ordered when firms' decision-making is based exclusively on private (firm-level) optimality (Uyl, 1984). 'Functionalism' implies the need for a strict demarcation between different interest groups in society in order to avoid the evolution of a monolithic power that dominates society. The structure of society should then promote vigorous conflict (Levitt, 1983). It is then inappropriate for a state regulator to confer with either an environmental pressure group, or with the regulated firms, or indeed with any affected parties. However, such

practice is commonplace: for instance, partnership and consultation between industry and the regulators was actively sought before the instigation of the (now defunct) BS7750 environmental management system (Regner, 1992). However, Power (1991) claims that industrial lobbying pressure transformed the EC's Eco-Management and Audit Scheme (EMAS) from its drafted mandatory status to its legislated voluntary status: this might be classified as just the kind of encroachment which strict adherence to functionalist principles might have avoided. It is noteworthy that the Brundtand Commission (WCED, 1987) explicitly calls for a sympathetic relationship between the regulator and industry in moving forward towards sustainable development.

Perhaps the most vociferous proponent of functionalist theory is Milton Friedman who advised the Reaganite government and assisted in establishing the *laissez-faire* market-orientation of the US economy. Friedman describes CSR as “a fundamentally subversive doctrine” (Friedman, 1963:133). Further, he explicitly comments upon the consideration of environmental impact in managerial decision-making:

There is one and only one social responsibility of business - to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition, without deception or fraud...Few trends could so thoroughly undermine the very foundations of our free society as the acceptance by corporate officials of social responsibility other than to make as much money for their stockholders as possible. (Friedman, 1963:133)

This might appear a radical conceptualisation of the role of the firm given the commonplace notion of ‘stakeholder dialogue’ described in the next section. The only stakeholder that should be of concern in the functionalist world-view is the stockholder. Friedman’s worldview is shared by some influential institutions. The Confederation of British Industry has called for environmentalism to be subsumed into a conventional SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis:

Clearly a new way of approaching the problem is required with the focus switching away from costs and burdens to concentrate on opportunities and benefits...One of the other problems of 1990 which hindered progress in corporate environmental performance was the tendency in some quarters to promote the idea that the environment as a business issue was different and required a special approach. This is clearly untrue. (Blaza, 1992:32-34)

This body of (influential) support is not a sufficient condition for the acceptance of the validity of corporate social responsiveness over responsibility. The utilitarian ethic is based on certain assumptions that may be adjudged to be inappropriate and/or anachronistic. These assumptions and the associated criticisms are documented below. Section 2.3.1 considers the historical

context for the NC tradition; Section 2.3.2 considers the NC assumptions of distributional justice; Section 2.3.3 outlines alternatives to the NC perspectives on welfare and welfare measurement; and Section 2.3.4 presents a brief summary of the NC position.

2.3.1 The historical context for utilitarianism

Adam Smith's 'invisible hand' concept (Smith, 1966/1776) and Bentham's examination of utility as a stream of psychological well-being (Bentham, 1970/1789) together arguably provide the foundations for utilitarianism (Kula, 1998; Edwards-Jones *et al*, 2000). Both authors were moral philosophers who conditioned their *laissez-faire* propositions with moral sentiments of self-enhancement and civil freedom. Smith's *The Theory of Moral Sentiments* (Smith, 1982/1760) chronologically pre-dates his *Wealth of Nations* (Smith, 1966/1776). It sets the moral foundations for the "happiness and perfection of a man, considered not only as an individual but as a member of a family, of a state, and of the great society of mankind" (Smith, 1966/1776).

The neoclassical debate should also be put in an historical context. The dominant firm-type in the latter part of the Eighteenth century was sole proprietors: the firm's owner also acts then as its manager. This industrial perspective is very different from the current domination of joint stock corporations where there is a divorce between ownership and control (Korten, 1995). Agency theory is concerned with the incentives that propagate a convergence in the motives of these two often disparate groups (Milgrom and Roberts, 1992). Given the imperfections of the monitoring and control mechanisms for managers, there is likely to be a managerial "zone of discretion" (Badaracco, 1991) wherein managers can choose an option that is non-profit-maximising. The Friedmanite response to such behaviour would be to refer to the inviolability of the "sanctity of the contract" (Friedman, 1970) between a firm's fiduciaries (managers) and its owners (shareholders). This inviolability implies that an individual manager's own ethics should be secondary: since he or she has chosen to be employed by the firm, then the firm's interests should be the only consideration (Uyl, 1984). However, this sanctity is premised on *self-interested* behaviour by a firm's owners: I would contend that it then seems indefensible to suggest that managers ought to be *expected* to act in anything but a self-interested way in their dealings with and for the firm. Following this argument, if the net effect of greener purchasing is to increase managerial satisfaction (and the extant incentive mechanisms and monitoring/enforcement regimes allow this) then there is no defensible ethical barrier to the manager's selection of the (perceived) greener alternative.

2.3.2 Neoclassical economics and the distribution of resources

The justification for *laissez-faire* economic policy is the aforementioned Fundamental Theorem of Welfare Economics and the associated concept of Pareto optimality (Cowell, 1986). The Pareto principle is concerned only with *efficiency* in resource allocation, not with *equity*. Wiles and Routh (1984) express this poignantly:

A Pareto-optimum is said to obtain when nothing more can be given to the hungry, the cold, the ragged and the homeless without incommoding the glutton, the miser, the usurer and the play-boy. (Wiles and Routh, 1984:313)

Libertarian philosophers (e.g. Nozick, 1974) define the utilitarian position as just in terms of the distribution of resources: Nozick proposes that distributional justice can be assessed in terms of the *process* of allocating resources as opposed to the *outcome*. Nozick stresses the returns associated with individual effort and application and proposes that rewards, measured in terms of material consumption levels, should be allocated accordingly. The corollary of this argument is that as few limitations as possible be put on market exchanges, as such barriers hinder entrepreneurship.

What is implicit in the Nozick argument is the notion of work being a means to an end - that of earning a salary that can be used to purchase commodities offered in the market. The employee is then simply an element of the production system. This corporation/employee relationship is embodied in Taylorism and Fordism: "In the past, the man was first; in the future, the system must be first" (Taylor, 1911:11). Chandler (1986) considers this organisational methodology to be a fundamentally dehumanised one. Responsibilities are delegated and monitored to co-ordinate the specialisation of the production process. Chandler proposes that this regime systematically stifles the evolution of personal and social relationships between employees within the firm as the manipulation of hierarchical control generally requires internal demarcation between employees at different organisational levels. Argyris (1964) argues that the Taylorist hierarchy typically enforces dependency and passivity in those employees at the lower echelons of the production process which undermines their maturity and independence. Schumacher (1973) provides a seminal critique of Taylorism, asserting that employees' interactions are highly personal affairs and thus that the evolution of small productive units facilitates the humanisation of the workplace. This is discussed further in Section 2.4.1.

Even those firms that operate a flatter hierarchy than the Taylorist model presented often might be accused of failing to adopt the Schumacher model of working relations (Welford, 1995). Under these employment conditions, if a manager has a personal agenda to improve working conditions for employees and/or choose more expensive fairly traded alternatives then such

behaviour might be ethically justified in light of the criticisms made above of NC distributional theory.

2.3.3 Neoclassical perspectives on welfare

In order to reject CSR, it is necessary to accept the NC position on welfare. In NC theory, consumption is treated as a substitute measure of societal welfare (Daly and Cobb, 1989). This implies that Friedman's 'sanctity of the contract' for fiduciary managers is premised on the assumption that the ultimate goal of society is to maximise production/consumption in accordance with the tastes of consumers, as this is assumed to correlate directly with maximising social welfare. Consumption is assumed to satisfy human needs. Marshall summarises the utilitarian position on welfare:

We fall back on the measurement which economics supplies of the motive, or moving force to action, and we make it serve with all its faults, both for the desires which prompt activity and for the satisfaction that result from them. (Marshall, 1920:92-93)

Under NC theory, there is no distinction made between human 'needs' and human 'wants'. It concerns itself with maximising the *opportunities* for satisfying these needs/wants through the market mechanism. NC is criticised by the humanist school (e.g. Maslow, 1954; Kamenetzky, 1992; Max-Neef, 1992). Mallman (1973) defines 'needs' as those requirements that are always found when the behaviour of human beings is analysed irrespective of culture, race, language, creed, colour, sex or age. Needs under this definition are thus not determined by social structures. Max-Neef (1992) development of fundamental human needs and satisfiers is, by contrast, linked to socio-political and anthropological elements. Max-Neef (1992) considers 'needs' as quite distinct from 'wants' and indeed the humanist school portrays some level of mutual exclusivity between the two:

Is the nature of the Ultimate End such that, beyond some point, further accumulation of physical artefacts is useless or even harmful?...Could it be that one of our wants is to be free from the tyranny of infinite wants. (Daly, 1992:21)

There is evidence to suggest that the NC assumption that consumption levels are directly correlated with welfare levels is unjustified. Fred Hirsch analyses the social function of consumption in *The Social Limits to Growth* (Hirsch, 1976). The most notable outcome of this research is that human satisfaction is not a function of absolute consumption levels but *relative* levels. Economic goods are defined by Hirsch (1976) as "positional goods" which provide social status. Since Hirsch's position is that *aggregate* advancement of consumption beyond a given point has no link with individual welfare, then an individual's welfare can only increase at the expense of some other agent in society, i.e. *relatively* to others, in direct opposition to the

NC perspective. His position does not imply that 'true' welfare levels have (or soon will) reach a peak, as the humanist school proposes qualitative changes to society and consumption patterns:

A sustainable society would be interested in qualitative development, not physical expansion. It would use material growth as a considered tool, not as a perpetual mandate.
(Meadows *et al.*, 1992: 210)

The notion of 'steady state' economics has come to prominence as a consequence of the sustainability agenda and the professed need to reduce throughput. With respect to the state's regulatory policy on firm behaviour and internal firm management, if the 'ultimate end' of consumption-maximisation that NC theory proposes contravenes the personal ethics of a fiduciary agent of a firm, then there may be just cause for that agent to contravene the 'sanctity of the contract'. As Daly states:

The stationary state would make fewer demands on our environmental resources, but much greater demands on our moral resources (Daly, 1971: 237).

This could be said to apply equally to managers as to society at large.

2.3.4 Conclusions on the Neo-Classical position

In summary, the NC position on the behaviour of firms is that their single objective should be profit maximisation within the confines of legislation. The role of the state then is to intervene in the market mechanism only in instances of market failure or instances of anti-competitive behaviour. NC economics adopts an anti-paternalistic position wherein individual consumers are, with some exceptions, allowed to choose the products that best satisfy their tastes. Under neo-classicism the price mechanism is sacrosanct in that it is the most efficient means of allocating resources.

The implications of this *laissez-faire* policy for firms are that the market mechanism and competition should ensure that only efficient firms survive. If it is efficient and profitable for the firm to adopt a greening or sustainability agenda then it should do so; it is only then *responding* to the environmental/social pressures as it would do any other business issue. Thus, the consideration of social issues - such as the working conditions for employees, distributional issues, constraints and thresholds of ecological sources and sinks - should be a concern of the firm if and only they affect profitability and/or they are required by legislation.

2.4 Socio-economic contributions

An alternative to functionalism in the CSR debate is provided by socio-economics. Coughlin provides a definition of socio-economics:

Socio-economics assumes that economics is embedded in society, politics and culture, and is not a self-contained system. It assumes that individual choices are shaped by values, emotions, social bonds, and judgements - rather than by a precise calculation of self-interest. (Coughlin, 1990:3)

Socio-economics rejects the compartmentalisation and delineation of NC in favour of a view of firms acting in a socially responsible manner. Clarkson proposes:

[T]o be socially responsible, a corporation must be profitable and responsive to the changing values, needs and expectations of the community and society in which it operates. (Clarkson, 1991:186)

Socio-economics depicts profitability as merely instrumental, i.e. a means to an end (survival in the marketplace), not an intrinsic goal unto itself. In this respect it mirrors the position adopted in Welford (1995). A schematic depiction of the socio-economic world-view is given in Figure 2. Stakeholder management is closely allied to socio-economics principles: the overlapping zones in Figure 2 depict the concept of stakeholder management. Freeman (1984) attributes the conceptualisation of stakeholders to the Stanford Research Institute, providing a definition in 1963: “those groups without whose support the organisation would cease to exist” (Freeman, 1984:31). Rhenman (1968:12) provides a broader definition: “stakeholders designate the individuals which depend on the company for the realisation of their personal gains and on whom the company is dependent.”

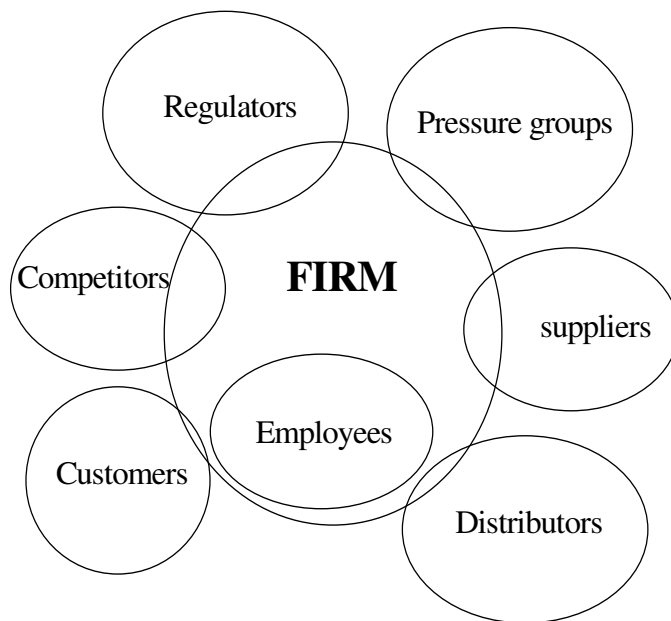
Stakeholder management has spawned a significant debate (e.g. O'Toole, 1985; Alkhafaji, 1989; Freeman, 1984). Ansoff provides the framework for stakeholder theory:

[although] 'responsibilities' and 'objectives' are not synonymous, they have been made one in a 'stakeholder theory' of objectives. This theory maintains that the objectives of the firm should be derived balancing the conflicting claims of the various 'stakeholders' of the firm. (Ansoff, 1965: 39)

Stakeholder management implies that the configuration of an organisation's resources should be planned in relation to its wider business environment. Further, the designation of the relevant stakeholder groups, the firm's 'moral community', is contingent upon a number of situation-specific variables and the definition of 'stakeholder' that is used. Under Freeman (1984), environmental pressure groups are excluded from the moral community unless their negative

propaganda has the capacity to enforce the firm's bankruptcy: a mere reduction of profits is insufficient. However, adopting a wider definition, such as Rhenman (1968), environmental agencies are more likely to be designated as stakeholders.

Figure 2 Schematic presentation of the socio-economic view of the firm in society (Hussain, 1999)



There are two fundamental ethical schools of justification for CSR as a duty for the firm under socio-economics and the associated promotion of stakeholder management. 'I&We' theory (Etzioni, 1988) provides an analytical framework for evaluating behaviour, both in terms of relations between individuals and firm/society relations. As such, 'I&We' provides a diagnostic tool for evaluating problems in society and a prognosis of change. 'Social permission theory' (Davis, 1983) presents a justification as to why firms should be duty-bound to exceed mere compliance with legislation, i.e. why they should be the instigators of social improvement for its own sake. These two theories - 'I&We' and social permission theory - are discussed in Sections 2.4.1 and 2.4.2 respectively.

2.4.1 'I&We' theory

Etzioni (1988) proposes that individual choice is a response based upon both moral and social values as well as the rational egoistic drive to utility-maximise. Etzioni's argument stems from Elster's 'multiple selves' analysis, wherein an agent's 'metapreference' constructed from a moral code of conduct, is used to evaluate a 'base preference' (Elster, 1985). In simple terms, 'should' determines 'like'. The egoistic preference corresponds with the 'I' and the socially conditioned

meta-preference with the 'We' of Etzioni's 'I&We'. Etzioni describes the I&We vision as a synthesis:

[a] philosophical convergence developing between individualistic, atomistic positions and collectivistic positions (Etzioni, 1991: 59).

The I&We synthesis requires that neither the individual agent nor the community be cast in a role of subordination. Unlike NC utilitarianism, there is no ends-hierarchy: both elements are interlocking and mutually dependent. Etzioni (1988) does recognise that there can potentially be a tension between the two 'selves' (community-orientated and self-orientated) but explicit recognition of the validity of both 'selves' is of paramount importance.

Under the NC world-view, the only communitarian (i.e. the 'We' element in I&We) aspect to behaviour that is relevant is consumer tastes and tastes are generally treated as exogenously determined in economic modelling. A move towards green consumerism is difficult to validate under NC as it is an overt preference-shift derived from a communitarian ethic³. Under the NC tradition, tastes are both immutable and by nature individualistic:

[Under NC theory] preferences are assumed not to change substantially over time, not to be very different between wealthy and poor persons, or between persons in different societies and cultures. (Becker, 1976: 5)

Any change in taste that might occur in the long term is deemed out with the 'pre-analytical vision' (Schumpeter, 1934) of economics or is deemed irrational and unpredictable (Becker, 1976; Stigler and Becker, 1977). The formulation of tastes is *within* the domain of socio-economics: an evaluation of changes in meta-preferences can predict and/or explain changes in purchasing patterns.

Under 'I&We', individuals are deemed to operate subject to a value system which is a balance of egoism and extra-individual forces. These extra-individual forces arise from group processes, power relations with other societal agents, and the norms and cultures of the communities that the individual is a member of. These community sets might range in magnitude from all sentient beings on the planet through to intimate familial relations; they may include (if applicable) the firm employing the individual. The egoistic preference can be conditioned, even *manipulated*, by membership.

³ It would be irrational for the individualistic 'I' to confer changes in tastes towards green commodities owing to the 'free rider' effect: any personal unilateral changes in consumption patterns have a miniscule effect in isolation on global environmental issues such as ozone depletion and global warming.

The definition of “*Homo economicus*” or “person-in-community” in Daly and Cobb (1989) is very close to Etzioni’s ‘I&We’. They propose that, “individuals are without doubt interested in acquiring commodities, and much of their behaviour expresses just the rational self interest attributed to *Homo economicus*” (Daly and Cobb, 1989:165). However they draw out the mutual interdependence between the community and *Homo economicus*:

The well-being of a community as a whole is constitutive of each person’s welfare. This is because each human being is constituted by relationships to others, and this pattern of relationships is at least as important as the possession of commodities. (Daly and Cobb, 1989: 165)

Daly and Cobb (1989) draw out the implications of person-in-community with respect to the need to develop an economic order that supports the pattern of personal relationships that make up the community. The central argument is this: if individuals within society are responding in part with respect to the communitarian ‘We’ then there is an argument that firms, which are ultimately owned by individuals, *should* do the same. However, I&We is explicitly *not* a call for eco-heroism at the expense of profitability (the ‘I’ of the firm), in the same way that I&We does not support a shift towards a communitarian biocentrism, e.g. Leopoldian land ethic (Leopold, 1949)⁴. One vision of a I&We firm, one that thus satisfies the Daly and Cobb (1989) call for a change in the economic order, is the aforementioned humanised, community-based one presented in Schumacher (1973). Similarly, Piore and Sabel (1984) depict a post-Fordist mode of organisation that characterises the firm as responsive to the network of communities that constitute the firm as an entity. The defining feature of the firm in each case is as follows:

rather than merely promising economic benefits, a moral firm should contribute to the development of the individual's autonomy and self-respect (Bowie, 1991: 177).

There are of course problems and conflicts associated with stakeholder management:

it is at best difficult to balance the freedom of individuals and the consequences of their participation in public affairs against the interests of the corporation (Andrews, 1987: 75).

However, there are similar conflicts in the development of sustainability; the fact that there is no one definitive optimal path or balance should not imply that the concepts of either sustainable development or stakeholder management are defunct. What is apparent from an evaluation of ‘I&We’ and ‘person-in-community’ is that there are strong ethical grounds for a firm to attempt follow a course of CSR.

⁴ The Leopoldian land ethic considers ecosystem health as a proper focus of moral concern. The rights of individuals are then derived from those of the whole community; as such, the Leopold ethic can be criticised as being totalitarian (Edwards-Jones *et al.*, 2000).

2.4.2 Social permission theory

Social permission theory provides an ethical justification for the state intervening in the operation of the firm. The 'intervention' implied goes beyond the NC role of the state that is to facilitate the operation of the market and to intervene in firm operations to counteract anti-trust behaviour. As social permission theory attempts to designate the appropriate level and content of state intervention, it is not a justification for stakeholder management *per se*, but it has been used as such (Davis, 1983). The fundamental assumption of the theory is that the state not only has legal recognition of the firms operating in its jurisdiction but is also their *social creator*. Davis (1983) summarises this position:

Society has entrusted to business large amounts of society's resources to accomplish its mission, and business is expected to manage these resources as a wise trustee for society. (Davis, 1983: 95)

The social permission argument is quite different to the NC argument for the existence of the firm, *viz.* Coasian transactions costs (Coase, 1937). Firms are deemed to evolve under NC as a direct response to price signals in the market.

[Transactions costs theories] infer the evolutionary problem that must have existed for the institution as we see it to have developed. Every evolutionary economic problem requires a social institution to solve it (Schotter, 1981: 2)⁵.

This NC argument, wherein the firm is an autonomous entity located in society but not obligated to it, is challenged by Granovetter (1991):

[firms] are constructed by individuals whose action is both facilitated and constrained by the structure and resources available in the social networks in which they are embedded....the shape of these institutions results more from the original structure of personal relations than from the exigencies of the market. (Granovetter, 1991: 78-79)

Under Granovetter's argument, virtually any form of state intervention is legitimised as society is assumed to have germinated and developed the organisation. However, I would argue that obligation beyond legal compliance is an appropriate operating ethic for the firm if and only if the firm is a mere 'trustee' of societal resources. Firms must use natural resources to produce their output and must operate within the laws of the land: this is taken as given, even under the NC Friedmanite position. The 'trustee' concept goes beyond this and has some far-reaching implications. If the firm's entitlement to set its objectives or to maintain the property rights to its material assets is subject to some mutual compatibility with some 'social ethic' then a

⁵ Schotter's description of the firm as a 'social' institution only refers to the fact that the firm operates in a socio-economic system, not that the firm is somehow 'owned' by society.

hierarchy of rights exists. By extension, no individual in society has complete property rights to personal possessions, even if their consumption has no negative externality effect on other agents in society.

A second criticism of social permission theory is that it is anachronistic. Korten (1995) demonstrates that the level of globalisation and international capital mobility is such that the role of governments vis-à-vis their relations with multinational corporations has changed. This is summarised by Ohmae (1990), cited in Korten (1995):

[M]ultinational companies are truly the servants of demanding consumers around the world...When governments are slow to grasp the fact that their role has changed from protecting their people and their natural resource base from outside economic threats to ensuring that their people have the widest range of choice among the best and cheapest goods and services from around the world...they discourage investment and impoverish their people.....the people - as consumers and as citizens - will no longer tolerate this antiquated role of government. (Ohmae, 1990: x-xi)

Ohmae's argues for an appropriate and modified response by the state to globalisation; on the other side of the argument, Kolk (2000) presents the evolving ethical role of the multinational in the sustainability debate. These discourses, although of paramount relevance to the greening agenda, are not pertinent to the debate on social permission theory. The point here is that even if multinationals were 'germinated' at some time in the past, the evolution of international trade and the associated diminution in the relative importance of the home/domestic market have changed things. Any notion of *duty* to the state in which the firm was founded is, I would argue, anachronistic.

Given these two criticisms - the communist nature of 'trustee' concept and the argument that it is anachronistic - I would propose that social permission theory is perhaps not a valid ethical support for fundamental state intervention.

2.5 Summary on ethical positions on corporate social responsibility

The discussion in the proceeding sections has presented and criticised the ethical arguments in three domains: how fiduciary agents should behave with respect to decision-making in the firm, how a firm should behave in society, and to what extent the state should intervene in firm behaviour. In each of these domains, any ethical prescriptions must pay due regard to real-world applicability: 'ought' must imply 'can'. The outcomes of the analysis are presented below for each domain in turn (Sections 2.5.1 to 2.5.3) comparing the NC and socio-economic perspectives.

2.5.1 The role of the employee

For the employee or fiduciary agent, there is no conflict if stakeholder management coincides with increased profitability: there is no ethical issue that needs to be resolved as long as win-win situations are still available. However, there is a growing body of evidence suggesting that win-win situations, i.e. the low hanging fruit, are progressively becoming less apparent for many firms. This implies a conflict between profitability and environmental performance. Gray *et al* (1993) find there to be a higher potential for tension than for congruence between environment and profitability.

If managers expect profitability to decrease as a result of their corporate decision then they are through personal choice violating the Friedman 'sanctity of the contract'. The NC response to such a violation is that the fiduciary is actually *decreasing* social welfare as a result. This is because society is deemed to be best ordered with 'vigorous conflict' between different interest groups/stakeholders and firms profit-maximising under competitive conditions; this permits consumer sovereignty under the price mechanism to apply. The criticisms of this NC perspective are that the utilitarian ethic pre-supposes that welfare can be measured by consumption, whereas there is evidence from the humanist school that welfare is derived also from community relations: the NC "fallacy of misplaced concreteness" (Daly and Cobb, 1989). The hierarchical and dehumanising institution that the firm can evolve into if applying the NC prescription is criticised by the Schumacher school (Schumacher, 1973).

The socio-economic perspective on the role of managers is that they do and indeed should operate in accordance with I&We (Etzioni, 1988). This implies that they must counterbalance the sometimes conflicting claims of their various 'moral communities', one of which is the firm. Further, I&We proposes that it is ethically robust for the individualistic 'I' element to enter into the manager's decision-making if tempered by the communitarian 'We'. In the case where the firm fails to meet the conditions set out in Bowie (1991) for a "moral firm" then the appropriate individualistic response might be for managers to promote their own agendas within the firm - for instance, sustainable development - even if these agendas conflict with the firm's objectives. In this respect, the manager is doing little else than operating as a utility-maximising free agent. The divorce between ownership and control can provide the opportunity for this:

Management is frequently only weakly responsive to stockholders. In fact, the management is more nearly the essential definition of the firm. The stockholders are investors who trade their holdings with considerable frequency and have no close relation to the firm. (Arrows, 1994:6)

I would support the Etzioni 'I&We' position. To consider either that *all* extraneous social factors are subservient to the need to promote the assumed objective of the firm (the NC position) or to consider that *all* decisions should be based on 'the greater good' (the humanist position) is I would contend flawed.

2.5.2 The role of the firm

Turning to the second domain, firm behaviour in society, the NC prescription for the maximisation of social welfare is corporate *responsiveness* to the rapidly changing business environment but the rejection of CSR. This responsiveness can legitimately have a long-term perspective: short-term losses associated with green and sustainability marketing and/or fundamental changes in operating processes as preparation for a changing market are appropriate under NC, but if and only if the guiding force for such eco-change is long-term profitability⁶.

The socio-economic perspective rejects the domination of the individualistic profit-motive (the 'I' of the firm) to the exclusion of CSR (the 'We' of the firm). The firm is deemed to have a social responsibility to balance the conflicting claims of *all* its stakeholders and also to adopt operational conditions within the firm that stimulate human relations and a network of communities within the firm. Social permission theory provides some validation for this argument, but I would criticise it for being anachronistic and fundamentally anti-capitalism and therefore inapplicable. Despite this, the fact that globalisation has implied that some firms are now such monolithic institutions that often dwarf nation states in terms of their financial clout implies a new type of responsibility should be borne by them, i.e. the 'We' of the firm.

2.5.3 The role of the state

Turning finally to the role of the state with respect to the firm, the NC perspective is one of *laissez faire* free market operation. State intervention is only appropriate then to correct market failures and to set up the conditions for the proper competitive functioning of the market and the price mechanism. The humanist school depicts the role of the state as being more pervasive and fundamental in that the dominant NC model fails to address the fundamental human needs of community involvement and 'self-actualisation' (Maslow, 1954). The NC retort to this criticism is that the promotion of such community networks is out with the domain of economics; *laissez faire* policies allow consumer sovereignty and any designation by the state of what is best for the consumer is paternalistic and totalitarian.

⁶ Some authors (e.g. Welford, 1995; Elkington, 1987; Schot and Fischer, 1993) have postulated that a necessary condition for firms' *survival* in the future will be the adoption of a sustainability agenda. If this is the case, then the best *response* of firms now is to apply sustainability best-practice: there is then no contradiction between the socio-economic and the NC schools vis-à-vis optimal firm behaviour.

Kolk (2000) documents the differences in ‘regulatory style’ vis-à-vis the interaction between the polluting firm and the environmental regulator that are applied in practice across different countries. The USA has, in the past, adopted a more adversarial style, with detailed and standardised compliance levels, and a severe penalty mechanism in the form of litigation in the event of non-compliance (*ibid.*). This style appears to be based on the NC functionalist argument: it is also a relatively transparent operational system, open to public scrutiny. In Europe in general there has traditionally been more stakeholder participation and cooperation in the setting of and particularly in the implementation of regulations (*ibid.*). Within the context of the ‘style’ of regulation is the portfolio of policy options that are available to achieve a given desired policy outcome.

I would support to some degree the criticisms made of the NC school vis-à-vis the role of the state, especially in the environmental domain. Under the NC tradition, social welfare is the aggregate of the private welfares of individuals in society and the role of the state is to maximise social welfare. Accepting this, there is then a need to appraise the meaning of and the measurement of private welfare changes. I would support the position of the humanist school in that consumption should not be used as a surrogate for welfare. Thus, the role of the state should be not only focused on material consumption (although this is important) but also the stimulation of ‘person-in-community’ (Daly and Cobb, 1989) and the development of institutions and networks that facilitate this. Turning to I&We once more, the ‘I’ of the state might be taken to be the traditional control of production efficiencies and the ‘We’ the provision of a community cohesion that allows non-material needs to be met.

However, it is noteworthy that the policy appraisal of environmental management that is the theme of this research does not rely on this worldview vis-à-vis the role of the state. The Arthurian ‘lock-in’ concept applied in the environmental domain in Chapter 6 and the market failure owing to asymmetric information in eco-labelling modelled in Chapter 8 are instances where state intervention is justified even under the NC school.

2.6 Chapter Summary

Under any market structure and in the context of any regulatory framework there will always be the potential to change the *modus operandi* of firms such that the net impact of their production on the natural environment is reduced. This change might come from within the firm through the voluntary actions of fiduciaries that choose to exceed regulatory compliance or the change may originate from extra-firm stimuli including tighter regulation. The greening of industry

literature is pervaded by a didacticism vis-à-vis how far firms should go in eco-reform that ought to be questioned but rarely is.

The fundamental controversy is whether firms and their fiduciary agents should stop at corporate social responsiveness or take a step beyond this to corporate social responsibility. In some respects this ethical argument has been muddled. Consider for instance Welford (1995):

What is required is a shift in paradigm towards an acceptance by industry of its ethical and social responsibilities. If that is an insufficient reason for change in a profit driven world then business should recognise that it is not only ethical to be environmentally friendly, but with the growth of consumer awareness in the environmental area, it will also be good for sales. Such an approach continues to leave aside the key concepts of futurity and equity however and these are fundamental to an approach which is about sustainable management.
(Welford, 1995:88)

The ethical argument is clearly side-stepped. It is inappropriate to do so owing to the fact that firms can always go a step further even if they have made strides already. The question of the extent to which the low-hanging fruit of win-win outcomes is pervasive is thus in some senses redundant; the ethical argument persists.

The NC argument stems from functional theory and utilitarianism (Uyl, 1994) and the associated influential work of Milton Friedman (Friedman, 1963; Friedman, 1970). I would argue that Friedman's "sanctity of the contract" (Friedman, 1970) between a firm's owners and operators is ethically moribund and anachronistic. The utilitarian ethic and Smith's invisible hand (Smith 1966/1776) is based on the premise that there is no divorce between ownership and control in firms and that individuals behave in a self-interested way. But then if fiduciary agents choose to green their firms so as to increase self-satisfaction then I would argue that this is merely a form of self-interested behaviour. A NC retort is that such self-interest ought to be subjugated owing to the welfare implications of the reduced aggregate consumption in society that is the consequence of such 'responsible' actions. But this assumes that social welfare is determined by consumption and consumption alone. I would accept the position of the humanist school (e.g. Max-Neef, 1992; Daly, 1992) that such a position is both morally objectionable and indeed not descriptively accurate.

Does this synopsis imply that the evangelical zeal of such authors as Roddick (1992) is in fact justified? I have argued in this chapter that this is not the case; the ethical foundations of social permission theory (Davis, 1983; Granovetter, 1991) are just as shaky as those of functional theory. The notion that the firm is a 'trustee' of societal resources implies a diminution of fundamental property rights in society. Further, the premise for social permission

theory is anachronistic; even if firms were 'germinated' in some particular state, globalisation has eroded this link and will progressively continue to erode it further.

I would argue that 'I&We' (Etzioni, 1988) is the most robust ethical foundation from which to answer the question of corporate responsibility versus responsiveness. 'I&We' balances egoism and extra-individual duty, the latter arising from group processes and the norms, cultures and values of stakeholder groups that the agent is a member of. 'I&We' can be applied at both firm-level and to individual fiduciary agents. It is a deontological ethic, implying that there is a rightness or wrongness that can be attributed to the actions taken by agents vis-à-vis sustainability irrespective of the consequences of these actions.

In some respects, the outcome of my ethical investigation vis-à-vis what firms *should* do appears bland and inconsequential in that the application of 'I&We' leads to what is in essence a pragmatic outcome, one that is empirically descriptive of most firms' behaviour, i.e. consider the application of sustainability principles but with a eye on the bottom line. It is however noteworthy that the position adopted by certain key agents in society deviates from this and the ethical argument is often evaded by contending that no conflict exists.

3 THE FIRM'S PERCEPTION OF ITS ROLE IN SOCIETY

3.1 Introduction

The previous chapter considered what the roles, responsibilities and motivations of the various agents in society (state, firms and fiduciaries) *should be*; the aim of this chapter is to provide some empirical evidence with regards what fiduciaries consider the roles, responsibilities and motivations of their respective firms actually *are*. This chapter is adapted from Hussain *et al.* (2006). In essence, the study outlined and discussed in this chapter evaluates the relative strength of corporate social responsibility *versus* corporate social responsiveness. There are few who would contend that *either* the ethical dimension alone *or* the profit-motive alone is the complete answer vis-à-vis why firms choose to adopt eco-innovations: the answer is a mix of the two.

There are two distinct methodological problems that arise in attitudinal and motivational surveys in the greening literature which the study methodology that I have applied attempts to address. First, if a firm's environmental manager is surveyed and asked if profitability is an important driver for eco-innovation and also if social responsibility is important, he or she is likely to simply respond in the affirmative in both cases. It is thus difficult to decipher the *relative importance* of the two broad drivers. Second, attitudinal surveys that have sampled TNCs are potentially subject to bias: many such firms have a corporate marketing message that conveys an impression that their business respective activities are driven almost in their entirety by CSR, and not profits *per se*. A survey respondent adhering to this corporate 'spin' would thus either state that there is no conflict between responsiveness and responsibility or respond that the firm acts in an environmentally and socially responsible manner *irrespective* of the impact on the financial bottom line. This reported statement may be empirically fictitious and thus systematically skew the survey results.

Although this latter systematic bias probably still remains in the study presented here to some extent, attempts have been made to ameliorate it in the survey design through the choice of the sample of respondents. Specifically the sample constitutes SMEs in one specific peri-urban district in Scotland (Dalkeith) with environmental management systems in place. SMEs in a particular locale with on-going environmental applications were chosen for several reasons. First, SMEs are numerous and their collective impact on ecosystems is significant and yet their behaviour vis-à-vis sustainability is relatively under-researched as compared with larger firms. Second, respondents are less likely to be feel required to provide responses that are conditioned by some corporate agenda/positioning/'spin' with respect to CSR. Third, respondents are probably in a corporate position such that the 'pinch' of the potential trade-off between

profitability and CSR is felt personally to a greater extent than is the case for an environmental manager in a larger firm. Fourth, the fact that there are environmental management tools *in situ* for these SMEs means that they are responding in terms of real-life experiences. Although many corporate managers might be convinced to join the greening bandwagon – there is an industry dedicated to getting them on board and selling them associated services/expertise – responses from those who have been at the sharp end are perhaps more relevant.

The survey methodology attempts to address the first aforementioned problem in motivational research, i.e. deciphering the relative importance of the two broad drivers (responsiveness and responsibility). The methodology used is Analytical Hierarchy Process and is discussed in Section 3.2. Section 3.3 sets out the details of survey design. Section 3.4 presents the survey results. Section 3.5 provides a discussion and chapter summary.

3.2 Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) is one variant of multi-criteria analysis (Edwards-Jones *et al.*, 2000). AHP uses a number of pair-wise comparisons between quantitative or qualitative criteria to assess the relative importance of each criterion. These can be arranged in a hierarchical manner known as a ‘value tree’ to form sets of attributes and qualities (levels) within these attributes. The simplicity of the AHP approach is that, unlike other forms of analysis such as choice experiments, the qualities (or levels) of different attributes are not directly compared. The AHP approach thus removes the need for complex survey designs and can be applied (in an extreme case) with only a single respondent. Choice experiments do not realise statistically robust results unless there is a sizable number of usable survey responses.

Under AHP, respondents first make pair-wise comparisons of the qualities within each attribute before comparing each of the attributes (Saaty, 1980). By way of an example, one of the attributes in the survey is ‘profitability’ but qualities *within* this attribute include ‘long term profitability’ and ‘short term profitability’. After the pair-wise comparisons between qualities, there is a pair-wise comparison across attributes, e.g. ‘profitability’ and ‘compliance with legislation’.

Other forms of conjoint analysis such as choice experiments place quite a high ‘cognitive burden’ on respondents in that they are asked to make comparisons across options that have a large bundle of attributes *and* levels of these attributes. Under AHP, respondents are not asked to make choices between *all* criteria (such as in the 5 point Likert Scale). Such choices may not deliver enough discrimination between motivations to make the results significant. As a consequence of the methodological structure, respondents in an AHP survey are less likely to

adopt mental short cuts by concentrating disproportionately on one attribute or level. The pair-wise comparison is framed in the form of a question: how important is criterion A relative to criterion B? The responses to these questions are typically coded (as is the case in this study) along a nine-point scale as set out in Table 1.

Table 1 Scoring system used to determine relative importance between AHP criteria.

Rating	
1	Two options are equally important
2	Between 1 and 3
3	Chosen option is slightly more important
4	Between 3 and 5
5	Chosen option is moderately more important
6	Between 5 and 7
7	Chosen option is much more important
8	Between 7 and 9
9	Highest possible degree of importance of chosen option over the other

If, for example, B is considered to be ‘much more important’ than A, then the reciprocal of the relevant rating is assigned (i.e. 1/7 as opposed to 7 if A were ‘much more important’ than B). As it is assumed that a respondent is consistent in judgements about any one pair of criteria, this use of the reciprocal allows only $n(n-1)/2$ comparisons to be made where there are n criteria. The ratings and their reciprocals are then collected in a comparison matrix, an example of which is given below in Table 2.

Table 2 Example ratings and reciprocals for AHP

$$\begin{bmatrix} 1 & 7 & 9 \\ 1/7 & 1 & 2 \\ 1/9 & 1/2 & 1 \end{bmatrix}$$

Weights are then estimated which are consistent with the relativities between the attributes or qualities contained in the matrix. Although there is consistency in the judgements made between any one pair of criteria, this is not guaranteed in judgements between pairs. The estimated weights aim to provide the 'best fit' for the observations (DTLR, 2001). This can be achieved by calculating the geometric mean of each row and normalising these by dividing by the sum geometric means for each row. For the matrix presented in Table 2 the associated weights are given in Table 3.

Table 3 Example weighting for AHP

	Geometric mean		Weight
Criterion 1	$(1 \times 7 \times 9)^{1/3}$	= 3.9791	0.7926
Criterion 2	$(1/7 \times 1 \times 2)^{1/3}$	= 0.6586	0.1312
Criterion 3	$(1/9 \times 1/2 \times 1)^{1/3}$	= 0.3816	0.0760
Sum		= 5.0193	1.000

Since its inception in the 1970s AHP has been used as a tool in complex decision-making in all sorts of fields due to the straightforward and convenient nature of the pair-wise comparison form of data input and analysis (Zahedi, 1986; Shim, 1989). Proponents of AHP claim that allowing respondents to choose between two clearly demarcated choices and then to determine to what level they prefer one choice over another helps to reduce the number of null responses (Hassam, 1978). The main criticism of AHP as a methodology is what is termed a 'role reversal phenomenon': simply by adding another option to the list of options being evaluated, the ranking of two other options, not related in any way to the new one, can be reversed (Dodgson *et al.*, 2001).

To the author's knowledge, there have been only two applications of AHP in the broad area of environmental and natural resource management: Proctor and Drechsler (2001) and Ananda and Herath (2002). The aim of both these studies was to reach consensus on management decisions and priorities in a manner similar to Delphi exercises, but in a way that also elicited the relative utilities of different management options. Both studies sampled experts, resource managers and stakeholders. Proctor and Drechsler (2001) applied AHP to determine relative preferences concerning land use for tourism in Australia whereas Ananda and Herath. (2002) focussed on the perceived quality of wilderness areas in various ecosystems (Ananda and Herath, 2002). To my knowledge, AHP has not been applied to the greening of industry.

3.3 Survey design

The study consisted of a round of telephone interviewing of potential firms selected from a database provided by Midlothian Enterprise Trust in Scotland in summer 2005 in order to determine availability and desire to participate in the survey. The final sample consisted of seven SMEs. As discussed in the previous section, AHP can function with such a small number of respondents⁷. A pilot survey was drafted and comments received (and amendments made) based on the responses of two independent consultants from Midlothian Enterprise Trust who each specialise in corporate sustainability/CSR issues and who each had extensive experience in EMS applications for small firms. The final format of the questionnaire is outlined in brief below and is provided in full in Appendix 1. Table 4 provides a synopsis of the four sub-sections of the questionnaire and Table 5 outlines the amenities and the associated characteristics/qualities.

Table 4 Synopsis of the AHP questionnaire

1 <i>Nature of the firm</i>	General information collected about the firm such as number of employees, current sales and major product lines
2 <i>Nature of the firm's EMS</i>	Information collected on the length of EMS application, the type of certification (if any) and environmental reporting and auditing issues.
3 <i>Drivers for incorporation of EMS into business plan</i>	<p>This section determines the relative importance of 22 potential internal and external drivers using a six-point scale to deliver qualitative data on the relative importance of each driver.</p> <p>Questions also set to determine the intra-firm and external business environment at the time of EMS adoption, i.e. the importance of each of these 22 drivers in terms of the decision to adopt.</p>
4 <i>AHP application</i>	This section is the AHP application and there are 5 amenities considered: 'profitability'; 'compliance with legislation'; 'competitiveness'; 'social'; 'environmental'.

The two/three characteristics in each amenity were presented as a pair-wise comparison applying the 1-9 AHP scale. A pair-wise comparison was then made between each of the 5 amenity groups, i.e. 10 such comparisons. A final section asked for any further comments.

⁷ The total pool of potential respondents was relatively small owing to the low uptake of EMS by the SME sector in general and the requirement that respondents be based in a specific peri-urban area. I set the latter constraint as responses with regards social/community factors would then be consistent as they all pertained to Dalkeith in Midlothian, near to Edinburgh.

Table 5 AHP amenities and characteristics/qualities

Amenities of EMS	Characteristics of Amenities
Profitability	<ul style="list-style-type: none"> • Short-term increase in profits • Increase in production efficiency • Long-term increase in profits
Compliance with legislation	<ul style="list-style-type: none"> • Compliance with current legislation • Avoiding fines for non-compliance • Compliance with pending/future legislation
Competitiveness	<ul style="list-style-type: none"> • Increased competitiveness in present market • Opportunity for products to enter new market niches • Improved public perception
Social	<ul style="list-style-type: none"> • Improvement in relations with local community • Improvement in relations with regulators
Environmental	<ul style="list-style-type: none"> • Environmental benefits from decrease in resource use (energy and raw materials) • Environmental benefits from reduced emissions to air

3.4 Study results

The study results are categorised as follows: Section 3.4.1 provides a synopsis of general firm characteristics; Section 3.4.2 presents results for the drivers for EMS adoption; and Section 3.4.3 presents the AHP results.

3.4.1 General firm characteristics

Table 6 provides a synopsis of the seven firms in the survey. Six out of seven respondents were either general managers or owners, whilst the remaining respondent was an environmental/human resources manager. Only 2/7 respondents chose to discuss turnover and so these results are not presented. None of the firms had an allocated R&D budget although one firms intended spending 3-4.5% of gross 2005 turnover on efficiency improvements.

Table 6 AHP survey: general firm characteristics

<i>Firm</i>	<i>Type of Firm</i>	<i>Employees</i>	<i>EMS certified</i>
1	Courier Service	16	N/A
2	All wood custom-fitted office furniture	80	2002
3	Upholstered furniture and foam products	34	2003
4	Custom fabric creation and dying	18	N/A
5	Conference and Retreat Centre	61	1998
6	Shop-fitters	13	2000
7	Custom-fitted cabinetry, shelving and wardrobes	31	1999

In terms of the extant EMSs, 5/7 were certified under ISO 14001, with 1/7 having a certification pending and the last firm choosing not to certify. 5/7 produced a periodic environmental report, with 4/5 being yearly and 1/5 every two years. 4/5 reports were externally published, with the fifth respondent being in the process of deciding whether or not to do so.

3.4.2 Drivers for EMS adoption

Table 7 summarises the means and standard deviations of the responses pertaining to the drivers for adopting the EMS in each respective firm. A 6-point scale was applied with 1 being highly insignificant and 6 being highly significant.

Table 7 AHP application: drivers for EMS adoption (7 respondents)

<i>External/Internal Drivers</i>	<i>Means: range 1-6 (Standard Deviation)</i>
Change in firm's organizational structure	1.00 (0)
Change in firm's upper management	2.14 (1.68)
Change in firm's location	1.29 (0.76)
New technology	1.00 (0)
New supply challenges	2.29 (1.50)
Emergence of new industry niches	3.86 (1.07)
New national regulations	3.43 (0.79)
New EU regulations	2.29 (1.11)
Voluntary agreements with regulators	1.00 (0)
Increased competition, nationally	4.29 (0.76)
Increased competition, internationally	1.00 (0)
New or changing customer needs, nationally	5.00 (0.58)
New or changing customer needs, internationally	1.14 (0.38)
Change in suppliers' needs or values	3.86 (2.19)
Change in distributors' needs or values	2.86 (2.19)
Change in shareholders' needs or values	1.00 (0)
Change in financial service providers' needs or values	2.57 (1.27)
Change in insurance providers' needs or values	2.86 (0.90)
Change in consumers' needs or values	5.29 (0.49)
Increased pressure from non-governmental organisations	1.57 (0.79)
Increased pressure from the local community	2.71 (1.70)
Suggestions for improvements or changes from employees	2.43 (1.40)

The small sample size of 7 limits statistical significance but given this caveat the following observations can be made. First, the intra-firm drivers appear to be weak i.e. changes in structure, management and location as compared with extra-firm drivers. The mean score for the former is 1.69/6 whereas for the latter it is higher at 2.79/6. Case study analyses in the greening literature (e.g. Schot and Fischer, 1993) often present a 'Road to Damascus' type awakening in upper management that propels the firm towards the sustainability paradigm. The results do not support this model of eco-reform, but the sample size also means that it cannot be rejected. A second finding is that national drivers (competition, regulation, customer needs) are far stronger than international. Given the geographical focus of the firms surveyed, this is perhaps predictable.

The strongest drivers are on the demand side, in terms of changes in/new consumer needs and values, scoring means of 5.29/6 and 5.00/6 respectively. The next most important drivers are increased national competition (4.29/6) and new industry niches (3.86/6). It is perhaps noteworthy that these market forces (the 'carrot') are more dominant than the 'stick' of regulation (3.43/6 for national and 2.29/6 for EU regulations). This is in part perhaps because SMEs have been shielded to an extent by governments from the added regulatory burden of environmental compliance.

3.4.3 Analytical Hierarchy Process study results

The overall results from the AHP section of the survey are set out in Table 8. As discussed above, AHP is a three-stage process vis-à-vis the survey design. First, the respondent is informed of the attribute categories (five in this case). Second, pair-wise comparisons are made between each of the qualities within each attribute category. Third, pair-wise comparisons are made between attribute categories.

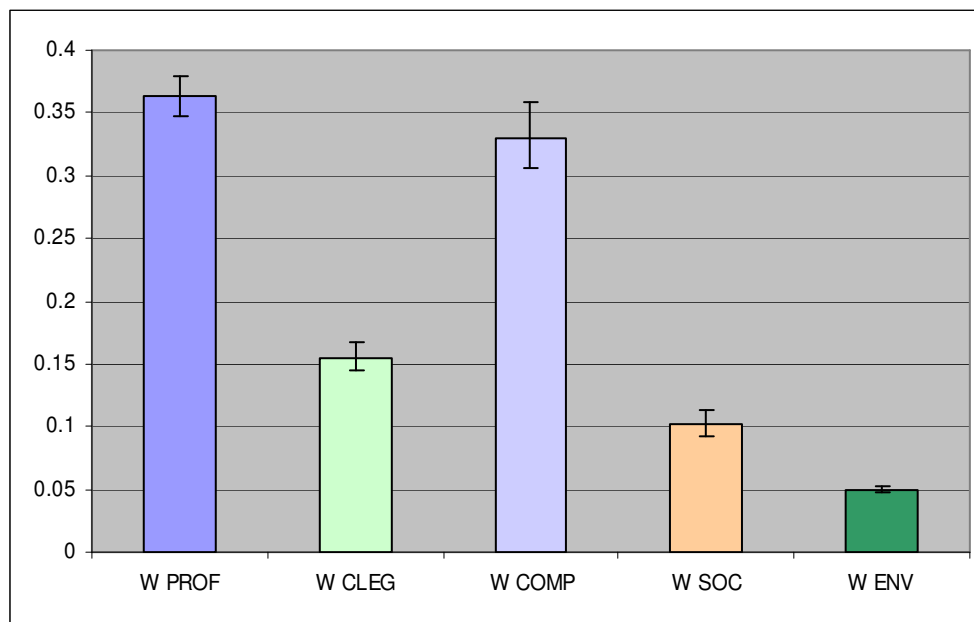
The third stage provides an overall weighting for the category. This overall weighting is then split between the qualities within that attribute category based on the second stage results, by multiplication of the quality weights by the weights of the associated attributes. The ordering here is important in that the demarcation between qualities may be less than absolute, e.g. 'increased competitiveness in present market' (within the 'competitiveness' attribute) might overlap with 'short term increase in profits' (within the 'profitability' attribute). However there is no direct comparison made between these two qualities as they fall into different attribute categories. There is an implicit assumption within the AHP methodology that relative importance weights will be consistent between qualities within different attributes despite there being no direct comparison of these qualities.

Table 8 Results of AHP survey (7 respondents)

Characteristics of Amenities	Means (Standard Deviation)
<i>Profitability</i>	
Short-term increase in profits	0.076 (0.046)
Long-term increase in profits	0.224 (0.047)
Increases in production efficiency	0.063 (0.024)
<i>Compliance with legislation</i>	
Compliance with Current Legislation	0.054 (0.041)
Compliance with Future Legislation	0.0507 (0.020)
Avoiding fines for non-compliance	0.0489 (0.064)
<i>Competitiveness</i>	
Increased competitiveness in present market	0.11 (0.073)
Opportunity for products to enter new market niches	0.173 (0.141)
Improved public perception	0.0469 (0.0255)
<i>Social</i>	
Improvement in relations with local community	0.0729 (0.058)
Improvement in relations with regulators	0.028 (0.021)
<i>Environmental</i>	
Environmental benefits from decrease in resource use	0.038 (0.018)
Environmental benefits from reduced emissions to air and/or water and waste generation	0.0116 (0.011)

The results presented in Table 8 are the overall findings, i.e. the means presented in the second column are the contribution that that particular quality has on the respondent's decision to continue with his or her firm's EMS. A bar chart representation of these overall results is given in Figure 3.

Figure 3 Weightings from AHP results: attribute categories



W=Weighting

PROF=Profitability

CLEG=Compliance with legislation

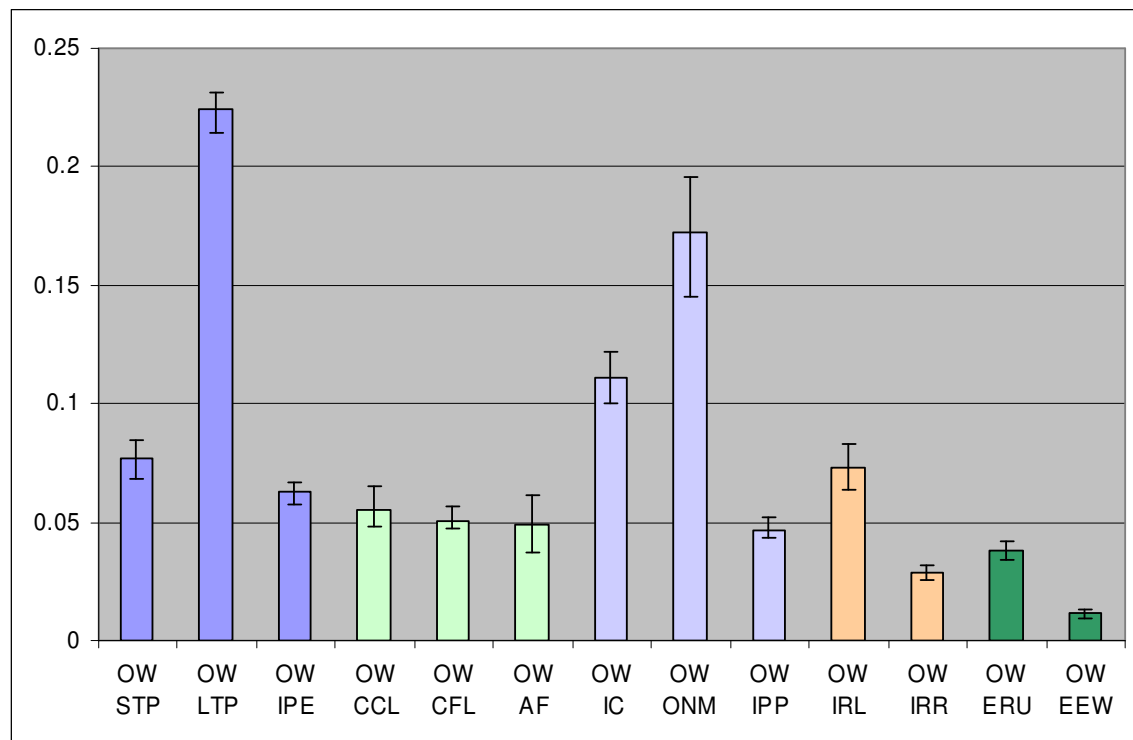
COMP=Competitiveness

SOC=Social

ENV=Environmental

Figure 4 provides a similar bar chart but with the results from only the third stage of the AHP, i.e. the relative weightings applied to the 5 attribute categories. The narrow vertical bars give the 95% confidence intervals although the small sample size implies that such a parametric test may not prove reliable.

Figure 4 Weightings from AHP results: individual attribute qualities



STP	Short-Term increase in Profits
LTP	Long-Term increase in Profits
IPE	Increase in Production Efficiency
CCL	Compliance with Current Legislation
CFL	Compliance with pending/Future Legislation
AF	Avoiding Fines for non-compliance
IC	Increased Competitiveness in present market
ONM	Opportunities for Niche Markets
IPP	Improved Public Perception
IRL	Improved Relations with Local Community
IRR	Improved Relations with Regulator
ERU	Environmental benefits decreased Resource Use
EEW	Environmental benefits from reduced Emissions to Environment and Waste generation

The quality with the strongest contribution is clearly long-term profitability, whereas the contribution of the qualities within both the ‘environmental’ and ‘social’ attributes are all very low in terms of global influence. In particular, an EMS is in fact designed to realise (through the installation of a management system) a reduction in impacts on the natural environment, both in terms of resource use and waste generation; yet the two qualities within the environmental attribute score as the *lowest* (and the third lowest) contributors as drivers to on-going EMS adoption. The four qualities that are clearly stronger influences than the others are *all* market forces, i.e. short and long-term profitability, increased competitiveness and niche markets.

3.5 Chapter summary

AHP has not to my knowledge been applied to date in the greening of industry and there have been relatively few applications in environmental management in general. I would argue that as a methodology it is ideally compatible with the type of academic enquiry that constitutes the content of this study, i.e. the determination of a trade-off between corporate responsiveness and responsibility. Other survey-based methods that might be applied to elicit the extent to which CSR *per se* applies are problematic in that most firms would *describe* themselves as 'responsible' and yet it is difficult to validate (or refute) this self-assessment. The essence of the AHP study approach was as follows: *given* that responsibility is to some greater or lesser extent part and parcel of the *modus operandi* of the firm, how important is it compared with other operational concerns?

The choice of the type of firms to sample from in this survey was deliberate. Respondents from an SME are arguably less minded to provide a pre-conceived corporate response ('spin') with respect to motivations for adopting an EMS. They are less likely to have 'worked up' a CSR image that is carried forward into survey responses; 6/7 respondents were either owners or general managers and thus very much at the 'coal face' in terms of dealing with the financial impacts of the choices made. So it is likely that responses are genuine as compared to surveys of multi-nationals. The other imperatives in the choice of sample were to select SMEs from one particular region with a strong local cultural identity, and ones that had applied an EMS. The application of an EMS is much less common across SMEs as compared with larger firms that enjoy greater economies of scale. Thus the survey is intentionally biased towards proactive firms with regards the greening agenda. I would thus argue that the sample would have a higher proclivity (compared to a random sample of Scottish firms) to display evidence of corporate social responsibility as opposed to simply responsiveness.

This makes the outcomes of the survey more noteworthy. The strongest finding from the results is that the drivers that might be linked to CSR (the environmental and social benefits arising from the EMS) were amongst the least significant drivers whilst long term profitability was clearly the strongest driver. In both the AHP and the analysis of drivers for EMS adoption, the 'carrots' of profitability and niche marketing were marked higher than the 'sticks' of regulation and community and/or NGO pressures⁸. This outcome does not necessarily imply that these firms see their roles as being primarily profit-accumulation without regard for community and environmental impacts: an assessment of the drivers for a particular eco-change (EMS application) may be atypical.

⁸ This finding has a particular bearing on the eco-labelling analysis that constitutes a significant element of my overall research, as this is a profit-driven approach to tapping into niche markets.

However, there is evidence that the 'We' element in the Etzioni 'I&We' paradigm (Etzioni, 1988), as discussed in the previous chapter, is perhaps weaker than the 'I' for these (and arguably other) firms. Further, there is clear evidence to suggest that both these elements are important, i.e. neither the extreme position of the Friedmanite 'functional theory' school (Friedman, 1970) nor that of the social permission theorists (e.g. Davis, 1983) resonates with the survey respondents.

4 BUSINESS STRATEGY AND SUSTAINABLE DEVELOPMENT

4.1 Introduction

The aim of this chapter is to set the context for the analysis on the supply of industrial sustainability (eco-innovation theory) and the demand for industrial sustainability (eco-labelling) that follows by charting of the development of the sustainable development paradigm itself as applied to industrial production. As was mentioned in Chapter 1, the source for the most commonly cited definition of sustainable development is the Brundtland report of the World Commission on Environment and Development (WCED, 1987). The Brundtland Report calls for industry to actively engage in the sustainability agenda. However, ‘operationalising’ corporate sustainability is difficult even from a theoretical perspective. For industry, the “needs of the present” for the firm in the aforementioned WCED definition is market survival; this depends on the profitability of the firm being sufficiently high so as to avoid bankruptcy and/or takeover. The rate of industrial eco-change may have been overstated in the literature. Further, the financial incentives for such a radical reform agenda have perhaps to date been insufficient, as purported in the PH (Porter, 1990) and discussed in the next chapter.

Given these propositions, firms might “need” to tread cautiously in their eco-innovations although such caution might, “compromise the ability of future generations to meet their own needs” (WCED, 1987). ‘Operationalising’ corporate sustainability can (but need not necessarily) imply that the “needs” of different stakeholder groups are mutually exclusive, therein requiring some *ad hoc* managerial ranking in the form of a stakeholder hierarchy. I simply restate this here as a preliminary introduction to some of the complexity entailed in defining corporate sustainability, a complexity that is explored in this chapter.

Although the Brundtland Commission definition is seemingly ubiquitous, it is neither the starting point nor the end point in terms of defining the corporate sustainability paradigm. Section 4.2 charts the development of the paradigm in general and Section 4.3 outlines and critiques measures of corporate sustainability⁹. Section 4.4 provides chapter conclusions.

4.2 Macro level sustainable development

The first major coordinated international meeting with regards sustainability was the 1972 United Nations Conference on the Human Environment that took place in Stockholm (Reid,

⁹ A comprehensive review of either of these subject areas would take volumes and would, in my opinion, be derivative and not contribute significantly to this research. I provide a synopsis merely to set the context for the main research analysis which follows. Mayer (2008) provides a recent review of common sustainability indices.

1997)¹⁰. The Stockholm conference was a precursor to the establishment of Environmental Protection Agencies in a number of countries (*ibid*). Colby (1991) proposes that little attempt was made to integrate development with ecosystem management; rather, “the principle strategy was to legalise the environment as an economic externality” (*ibid*). Colby criticises the “remedial focus” on the Stockholm conference, wherein damage control and monitoring were the guiding principles as opposed to concerted and coordinated holistic development that took into account economic injustice in trading relations between the developed and developing worlds. Stockholm was perhaps a useful although necessarily limited starting point. Stockholm signalled that the notion that ecosystems are non-exhaustible open access resources was and is inappropriate.

In 1980, the International Union for Conservation of Nature and Natural Resources (IUCN) published its *World Conservation Strategy*. IUCN (1980) defines development as “the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life” (Chapter 1.3). Under IUCN proposals, this development needed to be tempered by conservation policies, such that essential ecological processes and life-support systems as well as genetic diversity are maintained. IUCN (1980) proposes that this conservation ethic should be applied “cross-sectorally” and thus implicitly rejects the Stockholm position that ecosystem preservation should be an “activity sector in its own right” (*ibid.*). Further, the IUCN document calls for proactive behaviour in project appraisal, with a call for systematic *ex ante* environmental impact appraisal; this again differs from the Stockholm focus on *ex post* monitoring. Whereas the IUCN document explicitly addresses the issue of inequalities and justice between the developed and developing worlds in terms of income differentials and trading relations, the Stockholm conference implicitly endorsed the *status quo* in this respect. However, the IUCN document does not categorically determine how conservation and development might be integrated harmoniously.

The IUCN definition of ‘sustainable development’ was introduced at the IUCN Ottawa Conference on Environment and Development in 1986 (Reid, 1997). In the introduction to the Conference Proceedings, Jacobs and Munro (1987) present the five agreed requirements of sustainable development: first, the need to integrate conservation and development; second, the satisfaction of basic human needs; third, the achievement of equity and social justice; fourth, the provision of social self-determination and the preservation of cultural identity; and fifth, the

¹⁰ The development of sustainable development might arguably be traced back to Plato and in more recent times the classical economists of the Eighteenth century such as John Stuart Mill and Adam Smith. For a fuller discussion see Edwards-Jones *et al.* (2000), chapter 3.

maintenance of ecological integrity. The conference declared that this would require a paradigm shift, including in the behaviour of businesses:

The ability to practice design and management for sustainable development will require substantially different paradigms, institutional structures and methodological tools than have been considered adequate before (Jacobs and Munro, 1987:19).

A year after the World Conservation Strategy came the WCED report entitled *Our Common Future*, the culmination of three years work and investigation into social and environmental degradation, including consultation with developing nations (WCED, 1987). The Commission presents as its “central theme” the integration of development and environment:

Many development trends leave increasing numbers of people poor and vulnerable, while at the same time degrading the environment. How can such development serve next century’s world of twice as many people relying on the same environment? (WCED, 1987:4).

This leads on to the aforementioned definition of ‘sustainable development’ that has subsequently moulded thinking at all levels, from inter-governmental to local. The Brundtland Report appraisal is that reform is possible in the industrial domain:

humanity has the ability to make development sustainable...technology and social organisation can both be managed and improved to make way for a new era of economic growth (WCED, 1987:8).

This “growth” must be coupled with “equity” (*ibid*). It is noteworthy that the growth that WCED endorses is the conventionally measured increase in material production/consumption but WCED propose that this growth be decoupled from resource use/impact of environmental assimilation. The aim is “higher productivity, increased efficiency and decreased pollution” (*ibid*).

I would agree with the contention of Engel (1990) and Goodland (1991) that the Brundtland report appears either evasive or, at best, over-optimistic. The report calls for the world economy to expand “by a factor of five or ten” whilst simultaneously staying within ecosystem constraints. This proposed utopian solution is arguably a form of political diversion: the critical issues of inter and intra-national income disparities and population demographics, as highlighted by the Club of Rome’s systems model *The Limits to Growth* (Meadows *et al.*, 1972) as well as other systems models (e.g. Ehrlich and Holdren, 1971) are not discussed. Although the report is ethically routed in determining a more humanist mode of development the policy agenda that is defined is itself ethically vacuous. The following two statements are a synopsis of WCED (1987): the current mode of development is flawed in failing to meet

fundamental human needs and in stimulating resource-overexploitation, especially in the developing world; the only solution is material growth to alleviate poverty. This 'solution' fails to assign the responsibility for poverty to the developed world; further, it ignores ecosystem constraints.

The focus on human development that is sympathetic to ecosystems as opposed to conservation *per se* was taken up in the IUCN follow-up to *World Conservation Strategy* entitled *Caring for the Earth: A Strategy for Sustainable Living* (IUCN, 1991). Nine principles are presented. The founding principle is stated as "respect and care for the community of life" (IUCN, 1991). This 'community' is depicted as one large and complex interdependent system. The criteria for determining the success or failure to achieve this founding principle are given in principles 2 to 5: "improve the quality of human life; conserve the earth's vitality and diversity; minimise the depletion of non-renewable resources; keep within the earth's carrying capacity" (*ibid*). The last four of the nine principles might be termed 'enabling': change personal attitudes and practices; enable communities to care for their own environments; provide a natural framework for integrating development and conservation; create a global alliance. These principles are quite different from the WCED dictum of 'poverty alleviation implies the need for material consumption growth': IUCN (1991) states that political freedom, guaranteed human rights and freedom from violence and oppression are critical constituents of the sustainability paradigm.

The IUCN community-based, localised empowerment vision was the dominant one at the United Nations Conference on Environment and Development (UNCED), also known as the 'Rio Earth Summit', in 1992, which was attended by 166 world leaders. The UN General Assembly passed a resolution agreeing to the conference in December 1989 (McCormick, 1995). This has proved to be, in retrospect, highly significant in the development of sustainability, along with the associated 'Rio plus 5' summit monitoring implementations and progress in 1997 followed by 'Rio plus 10' in 2003. A UN summit on sustainable development was explicitly called for in the Brundtland report. The Rio Earth Summit produced five key agreements: the Framework Convention on Climate Change; the Convention on Biological Diversity; the Rio Declaration on Environment and Development which affirmed the right of Lesser Developed Countries to increase their output and 'develop'; the Forest Principles; "Agenda 21". Agenda 21 documents the actions required to 'operationalise' sustainability based on local communities coupled with free market principles. Although the policy direction leads on from *Our Common Future* (WCED, 1987), there is official endorsement of international co-operation and trade on a sustainable and more equitable footing between the developed and developing worlds, and the rights of the poor not just to fundamental material

needs but also to a role in decision-making and planning, i.e. localised empowerment and capacity-building so that change can be implemented.

Although the Brundland Report, IUCN and the Earth Summit had a slightly different focus, by 1992 a fairly coherent definition and implementation-strategy for sustainability had evolved: the integration of human development with ecosystem management; meeting basic human needs, which include self-determination, participation and empowerment; social justice and inter-generational equity.

Sustainable development as a paradigm has been discussed *ad nauseam*: there are more than 1000 documented definitions of the term (Edwards-Jones *et al.*, 2000). I would argue that it has become a shibboleth as a result. The contribution of economics to this discourse has been in defining the concept of sustainability using the capital theory approach (Stern, 1997) which itself stems from the seminal work of Hicks (1947). According to this approach, sustainability is attained if the sum of capital stock is non-decreasing over time. The capital stock is generally considered to have three components (Edwards-Jones *et al.*, 2000): manmade capital (i.e. plant and machinery); human capital (knowledge of innovations and production skills); natural capital (the raw material and energy inputs to the production system). Figge and Hahn (2004) also include what they term 'social capital' that they define to be the relationship between individuals and institutions. However, this type of capital is not commonly cited as a constituent part of the capital stock (Hanley, 2000). There is some considerable debate as to whether substitution should be permitted between the three types of capital. 'Weak sustainability' is said to arise if the aggregate capital stock is non-declining regardless of the individual capital stock levels, i.e. under the assumption of perfect substitutability. 'Strong sustainability' requires that not only the aggregate be non-declining but also that the natural capital stock be non-declining (Mayer *et al.*, 2004; Dietz and Neumayer, 2007). The 'critical natural capital' perspective (Pearce and Atkinson, 1993) permits some substitutability but with the caveat that some forms of natural capital (e.g. the ozone layer) have no manmade substitute and are critical for continuing ecosystem health and thus their levels should be non-declining over time. There is a related concept in 'safe minimum standards' (Farmer and Randall, 1998) wherein decisions or actions that imply irreversible environmental outcomes are not permitted unless this implies an intolerable cost.

Whilst originating at the macro level, the concept of sustainability has filtered down to the micro level. This includes analyses of individual consumption patterns, those of communities and those of firms and industry sectors. The next section discusses the role that industry has

been assigned in this sustainability discourse and the industrial response to the supposed socio-politico-economic paradigm shift.

4.3 Sustainability and industry

The debate at the macro level on sustainability has direct parallels at the micro level. The two aspects of the debate are, first, the definition of a sustainable enterprise and second, the measurement of corporate sustainability. These two aspects are of course intertwined: a definition of a sustainable firm is a pre-cursor to measuring the degree to which any enterprise has progressed toward meeting this goal. This discussion defines the structure of Section 4.3. Section 4.3.1 provides an introduction and sets the context whilst Sections 4.3.2-4.3.6 consider various sustainability performance indicators.

4.3.1 Background to corporate sustainability

The definition of sustainability at the micro firm level is arguably even more problematic than at the macro level. Consider for instance the three main characteristics of the sustainability of human-environment systems as set out in Mayer (2008): resilience to disturbances (both natural and anthropogenic drivers); desirability to human societies; and spatial and temporal scale boundaries. These characteristics are difficult to define for a single firm as they might not map well onto broader ecosystem sustainability but need to do so in order to be relevant. With respect to scale for instance, industrial globalisation implies that spatial scales differ, *viz.* politically-based boundaries (often the nation-state) versus trans-national corporations that might not delineate sustainability impacts at the same spatial resolution; in the temporal dimension, industrial project life cycles do not coincide with the timeframes for climate change mitigation policies, the latter being defined to at least 2050. This temporal schism also impacts on the desirability characteristic: inter-generational equity implies a longer time horizon than typically pertains to industrial decision-making on eco-innovation, with the requirement for pay-back periods described in months/years as opposed to decades. In some respects the resilience characteristic does map well onto individual firm behaviour but only if concepts of co-evolution and lock-in are applied to corporate agents (Hussain, 2003), as discussed in Chapters 6 and 7.

The natural environment provides two functions to the firm: resource inputs to production and an assimilative sink for pollution emissions. On the resource use side, the generic rule postulated by (amongst others) Daly and Cobb (1989) is that, for renewable inputs, exploitation should not exceed the growth rate. For non-renewable resources, the analysis is more complex and there are various methodological techniques for determining sustainable use such as the user cost method and net price method (Edwards-Jones *et al.*, 2000). With regards the waste assimilation function, the cardinal rule is that the rate of aggregate waste emissions should be

below the threshold assimilative capacity of the ecosystem (*ibid.*). Given this, two firms producing two identical products with identical technologies are not necessarily at the same level of sustainability (Callens and Tyteca, 1999). Consider a brewery located in the Highlands of Scotland that discharges water-borne waste emissions to a large, relatively unpolluted loch; the assimilative capacity may not be transgressed even after the wastes are emitted. Compare this to a brewery that releases its effluents into the River Clyde in heavily urbanised Glasgow: the assimilation constraint may well then be binding. Not only is the ecological dimension of sustainability different but also the social dimension. An urban brewery may be located in poorer residential areas, therein implying a disproportionate burden of the negative pollution externality being borne by the economically disenfranchised sectors of society. Further, population density and thus aggregate disutility is likely to be higher for emissions in urban areas *ceteris paribus*. This analysis implies that an isolated focus on the production systems of the two plants would mask certain sustainability issues.

One way of defining sustainability at the firm level is to consider the production process in its specific geographical and socio-demographic domain with respect to the three types of capital discussed in the previous section, i.e. manmade capital, human capital and natural capital. Feindt (2000) transposes the capital stock concept to firms: capital stock must be non-declining in each of the three dimensions but also increasing in any one dimension for any given firm that is being assessed. Note that this is a more restrictive condition than strong sustainability as the latter only requires natural capital to be non-declining as opposed to all three. The analysis of Feindt (2000) is described by Figge and Hahn (2004) as being “the strive towards a Pareto-optimal solution”. The parallel that Figge and Hahn (2004) make is a useful one in that Pareto optimality is a theoretical construct; its pragmatic application is virtually inconceivable away from the rarefied confines of textbook analyses (Cowell, 1986). Thus welfare economists defer to the less onerous Kaldor-Hicks criterion with *potential* compensation for agents whose utility declines *ex post*. The parallel that I would draw here is that there are different sub-categories even *within* each of the three classes of capital stock, e.g. critical and non-critical natural capital (Pearce and Atkinson, 1993), and significant debate *vis-à-vis* commensurability and comparability across sub-categories (e.g. Martinez-Alier, 2004); the achievement of the Feindt (2000) quasi-Pareto outcome is thus also near inconceivable.

A common feature across the literature *vis-à-vis* the definition of corporate sustainability is that there are three elements to a firm’s sustainability performance, *viz.* economic, social and ecological. Callens and Tyteca (1999) summarise the key types of data in these three elements that might be required. An adapted synopsis of their analysis is given in Table 9. It is noteworthy that some of these data are stocks, some are flows and others are types of

transformation. These data contribute to the evaluation of corporate sustainability but an important distinction should be made between *reporting* on corporate sustainability and providing a *performance assessment* of corporate sustainability. Although there is some overlap with respect to data collection, a reporting framework is concerned with corporate procedures and management *processes* as opposed to their *outcomes* vis-à-vis environmental and/or social impacts. Even if the data are common, how they are assessed may differ. For instance, green reporting has been mandatory in Denmark since 1996 (Kolk, 2000); the Danish accounts require the physical quantification of pollution emissions, the listing of discharge consents, data on the working environment and the designation of systems for employee participation (*ibid.*). Whereas a firm's reporting might be appraised with respect to how these data and information are set out and structured, an assessment of sustainability performance might be derived by (say) charting emissions per unit output over time or benchmarked against performance in the same industrial sector. Advocates of reporting postulate that harmonising reporting processes should in turn improve sustainability performance, i.e. form should influence content (Birchard, 2000; Milne *et al.*, 2008).

Table 9 Sample list of information required in the development of sustainability indicators at the firm level (adapted from Callens and Tyteca, 1999)

	SHORT TERM	LONG TERM
Economics aspects	Turnover, value added, output production, resources used as inputs (including recycled products and energy)	Profitability, competitiveness, market shares, product durability, research and development efforts
Social aspects	Employment, salaries, labour intensiveness or productivity, injury risk, noise, odour	Welfare, education, availability of (non-) renewable resources (including energy), size (SME vs. big), personnel rotation rate
Ecological aspects	Natural resources, wastes, pollution, transportation modes and distances	Global impacts: biodiversity, global warming, acid deposition, landscape, ultimate waste disposal, product recycling ability

The Global Reporting Initiative [GRI] has attempted to provide some harmonisation to corporate sustainability reporting, attempting to unify disparate national policies. It was set up in 1997 by the Coalition for Environmentally Responsible Economies [CERES] and included the main governmental, non-governmental and trade organisations active in the field. The GRI is affiliated with the United Nations Environment Programme. It is voluntary reporting

framework that is multi-variate in nature, combining both qualitative and quantitative measures. There are circa 80 indicators alone in the main guidelines, some of which are mandatory to report on whereas others are discretionary (Milne *et al.*, 2008). Of the qualitative measures, some are of a tick-box kind whilst others require a narrative (*ibid.*).

There has been criticism levelled against the GRI vis-à-vis the signal that it sends potential consumers (e.g. Hawken and Wackernagel, 2000; Gray and Milne, 2004; Milne *et al.* 2008). The publication of a CSR report that complies with GRI guidelines is a function of resource availability and corporate commitment but not of sustainability performance *per se*. Indeed I would postulate that the distribution of subscribers and advocates of GRI reporting might be skewed toward *less* sustainable firms: the multi-national corporations that attract the ire of the anti-globalisation lobby (e.g. Korten, 1995) are likely to both be well-resourced and be motivated to expend resources on attaining the positive publicity associated with GRI reporting. Milne *et al* (2008:8) refer to the "elephant in the bedroom" vis-à-vis the aspects of sustainability that the GRI fails to report on. Further, the documentation of official policies and procedures might not coincide with actual corporate behaviour; this might arise as a result of either imperfect intra-firm monitoring or indeed the intra-firm culture might not be consonant with the external GRI-compliant image. The former may be ameliorated through stricter verification and auditing procedures under GRI but the latter is a virtually insurmountable problem, especially if this culture extends to (or indeed is propagated by) senior management. In light of the methodological problems in terms of defining a firm's 'true' sustainability performance, data and information reported in the public domain (including GRI) has been scored on the basis of the range of issues discussed and/or on the intensity of the discussion (e.g. Morhardt *et al.* 2002: 229). This methodology puts environmental benign firms that do not have a lot to report and/or expendable financial resources for reporting at a disadvantage; adding topics and/or intensity can improve this score without necessarily improving performance (Morhardt, 2001).

Although the GRI is a reporting framework (as opposed to an assessment of sustainability performance *per se*) there are issues with respect to its design that are pertinent to the discussion on assessment frameworks: it is multi-variate as opposed to uni-variate; and it is non-monetised as opposed to being monetised. These two aspects are linked: corporate genuine savings (Atkinson, 2000) applies a uni-variate measure in converting all impacts into a single *monetary* figure so as to facilitate comparability with financial accounts; corporate ecological footprinting (Wiedmann and Lenzen, 2006) converts impacts into an alternative uni-variate measure termed a global Hectare (gHa). Each of these is detailed below (Sections 4.3.2-4.3.3) but I turn first to the generic debate on multi-variate/uni-variate and monetised/non-monetised industrial performance assessment.

There is a burgeoning literature on the merits of uni-variate monetised measures as compared with multi-variate non-monetised (or part-monetised) alternatives (see for instance Edwards-Jones *et al.*, 2000). A stalwart response by the 'pro' camp is provided by Turner *et al.* (2000) in their discussion of wetland valuation:

A strength of MCDA [Multi Criteria Decision Analysis] is that it provides both ecological and economic information as a basis for decision-making. A separate issue is, however, to what extent this information would in fact be taken into account in real policy-making situations. Ecological information may not adequately influence the final decisions in the socio-economic system. For example, short-term commercial interests and related financial gains may appear to be more persuasive than longer-term ecological conservation arguments. (Turner *et al.*, 2000: 15)

The gist of this argument is that those elements of a sustainability measure that either have no monetary measure or no direct surrogate price¹¹ will be ignored by decision-makers; given this, some (necessarily imprecise) monetary estimate is deemed a better alternative than its outright omission. Figge and Hahn (2004) argue that one of the shortcomings of some sustainability measures is the reliance on environmental economic valuation methods that are described as "difficult and still controversially discussed" (Figge and Hahn, 2004: 175). Although I have argued that such controversies are significant (Oglethorpe *et al.*, 2000), the application of these methods is now widespread in policy appraisal internationally¹². They are now an *integral* part of policies on climate change mitigation strategies; for instance, environmental valuation is embedded in the UK government's Social Cost of Carbon¹³. In figurative terms, I would argue that 'the horse has bolted' and thus this criticism of such measures is anachronistic; I would refute the proposition that the need to apply such methods "severely limits the practicability of absolute measures" (Figge and Hahn, 2004:175). Further, firms are likely to be even more focussed on the profitability 'bottom line' (as measured in monetary terms) than the state¹⁴, therein increasing the relative importance of having a monetary performance measure.

¹¹ The UN harmonisation of satellite environmental accounting includes both monetary and physical units in the same framework; although life cycle assessment is a physical measure of environmental impact (SETAC, 1993) elements such as the global warming potential do have a direct market surrogate value.

¹² See for instance: <http://www.defra.gov.uk/Environment/economics/evslist/index.htm>;
<http://yosemite.epa.gov/ee/epalib/nwlet.nsf/8ac8b89995567c70852564cd007aa1db/0ded1dd1e0bcdcfb5852564e100188f7a!OpenDocument>, last accessed 08.11.2008.

¹³ <http://www.defra.gov.uk/Environment/climatechange/research/carboncost/index.htm>, last accessed 08.11.2008.

¹⁴ Although developed world governments require regulatory impact assessment to be carried out to determine benefit-cost ratios (for instance US Presidential Executive Order 12291), I argue in MacLeod *et al.* (2008) that such *ex ante* assessments are often cursory and perfunctory. Such an attitude is arguably less likely to apply in the competitive corporate domain.

Callens and Tyteca (1999) distinguish between *absolute* and *relative* measures of corporate performance: absolute measures consider the sustainability of the firm *overall* whereas relative measures define the level of sustainability as benefits *per unit* of environmental or social impact caused. I would concur with the contention of Callens and Tyteca (1999) that any analysis of the level of sustainability of a particular plant should be relative, on a like-for-like basis. This is an important contention for this research. Eco-labelling is a means of facilitating green consumerism such that the subset of consumers that value the product attribute of 'environmental quality' (or more widely 'sustainability quality') can reflect their preferences in the market *for that product type* (cf. Chapter 8). If the analysis of sustainability is at the firm level then it is difficult for the consumer to translate this into meaningful green purchasing.

I have applied the term 'performance measure' above but (following Mayer, 2008) it is useful to distinguish a hierarchy, *viz.* sustainability frameworks, indices and indicators. Mayer (2008) defines an indicator as a variable that describes one single characteristic of the state of a system; a sustainability index is distinct from a framework in that the former aggregates many indicators whereas the latter simply presents indicators, often in related groups. The two sustainability indexes reviewed are Corporate Ecological Footprinting (CEF) which is considered in the next section corporate genuine savings (CGS) in Section 4.3.3. I then turn to some of the various extant relative sustainability frameworks: Sections 4.3.4-4.3.6 respectively outline eco-efficiency, Data Envelopment Analysis (DEA) and Sustainable Value Added (SVA).

4.3.2 Corporate Ecological Footprinting

The Ecological Footprint (EF) as a concept was originally coined and developed in the 1990s by two academics, Rees and Wackernagel, in their seminal publication entitled *Our Ecological Footprint* (Wackernagel and Rees, 1996). The EF was devised as an accounting tool for calculating the area of productive land a given human population appropriates in terms of resource inputs and assimilative capacity that support its consumption. This figure ('footprint') measured in a standardised unit of account termed global hectares (gHa) can then be juxtaposed with the land capacity of the biosphere ('biocapacity') required to provide these support functions (George and Dias, 2005; Wackernagel *et al*, 2005; Wilson *et al*, 2007). EF was designed to be policy-relevant: "[EF is] a planning tool that can help translate sustainability into public action" (Wackernagel and Rees, 1996:3). Perhaps the most significant application of EF is the World Wide Fund for Nature (WWF) publication entitled the *Living Planet Report*¹⁵, a

¹⁵ http://www.panda.org/news_facts/publications/living_planet_report/index.cfm, last accessed 12.11.2008.

bi-annual update on the state of the world's ecosystems that uses EF analysis as one of its two key indicators. The 2008 report estimates that the human footprint exceeds the planet's ability to supply natural resources by approximately 28% with the average global footprint being 2.7gha/person versus biocapacity of 2.1gha/person. Although such headline outcomes might broadly contribute to policy design, I would concur with the criticism of Moffat (2000) with regards its usefulness: the EF outcome is informative only in that it instructs lower consumption and/or decoupling resource use from consumption; it is thus a blunt policy tool if applied at macro level.

The EF method developed in Wackernagel and Rees (1996) has been subsequently modified and there are now three extant alternative methodologies: the component, compound and hybrid input-output approaches (Walsh *et al.*, 2007). Nonetheless, the overarching aim of these three differing approaches remains the same, *viz.* juxtaposing demand on and the supply of nature's resources (George and Dias, 2005). Over its short history applications in EFA have become increasingly popular, e.g. Chen *et al.*, (2007), Nguyen and Yamamoto (2007). The strength of governmental buy-in to EF is evidenced in Barrett *et al.* (2004), *viz.* EF studies for every local authority in England. What is common across all these studies is a clearly defined biocapacity linked to a distinct territorial area.

The same cannot be said of recent developments in EF at organisational level (e.g. Lenzen *et al.*, 2002; Holland, 2003; Foran *et al.*, 2005; Weidman and Lenzen, 2006; Lenzen *et al.*, 2007). van Passel *et al.* (2007) assert that the ethos of corporate EF is to allow firms to identify if and to what extent their productive activities place unsustainable demands on the biosphere. The global awareness of footprinting amongst consumers has spurred the evolution of a whole industry dedicated to the provision of EFA¹⁶. However, a fundamental critique of such applications is that there is no measure of biocapacity that can be attributed to a single firm; it is thus theoretically implausible to state that a firm's production is sustainable or not in absolute terms. However it is feasible under EF software applications to determine the relative performance of one firm as compared to another, but there are various methodological problems. First, component EFA use Life Cycle Assessment (LCA) and as the subjective determination of the system boundary may lead to results that lack validity (Suh *et al.*, 2004). Bouazzaoui *et al.* (2007) calculate the embodied energy of individual items using several LCA software/databases and find significant variability in results to be a factor. For instance, using Gabi4 software copper scores 36.7MJ/Kg whereas using the Eque database the result is 125

¹⁶ See for instance: <http://www.bottomline3.com/>, last accessed 12.11.2008; <http://www.bestfootforward.com/>, last accessed 12.11.2008.

MJ/Kg¹⁷. Second, input-output EF analysis uses expenditure data: this implies that (say) a flight that cost £1500 is attributed a 500% higher EF impact scoring than one costing £300, even if these costs pertain to economy class seats on the same plane. There are a host of other criticisms of corporate EF: data inaccuracies and information omission; assumptions with regard carbon sequestration potential of forest land (Kitzes *et al*, 2007); the omission of some greenhouse gases (Lenzen and Murray, 2003); assumptions concerning unproductive land and the multi-functionality of land (Moffatt *et al*, 2001); and an anti-trade bias (Dietz and Neumayer, 2007).

I would argue that corporate EF analysis is in its developmental infancy and the majority of methodological issues are likely to be mitigated over time. However the methodology will at best provide an accurate depiction in the change in corporate EF over time and/or relative performance; it *cannot* be used as a corporate sustainability measurement *per se*. Ecological footprinting is a relatively challenging methodology owing to the need to collapse all environmental impacts into a single comparable measure (gHa). In this respect its proponents are required to deal with the same kind of criticisms levelled at LCA. By comparison *carbon* footprinting is relatively trivial in that there are extant standardised CO₂-equivalent tables and there is a strong momentum behind its implementation¹⁸. This trend is however disturbing in that the ubiquity of the carbon footprint might veil the need for a more integrated approach to corporate environmentalism, *viz.* one that does not focus exclusively on climate change.

4.3.3 Corporate Genuine Savings

CGS is an absolute sustainability measure that attempts to internalise the externalities of the production against the firm's accounting ledger (Atkinson, 2000). This requires that the environmental and social costs of production be categorised, monetised and then subtracted from the conventional economic benefits of production, *viz.* value added. As an accounting framework CGS is based on weak sustainability in that natural capital is valued in monetary terms and its loss can be compensated for through increases in other capital endowments whereas the framework applies strong sustainability. CGS has two elements which constitute the 'sustainability spend': first, the environmental costs that are internally borne by the firm and second, those that are externalised. Atkinson (2000) follows CICA (1997) and focuses exclusively on the environmental costs, abstracting from the social costs. Atkinson (2000)

¹⁷ For details on the software/databases see: <http://www.izuba.fr/equer.htm>; <http://www.gabi-software.com/english/gabi/gabi-demo/?gclid=CMWkxbjwwZQCFQFuMAodWHqvGg>.

¹⁸ See for instance references to the UK government's carbon footprint tool and Tesco's policies: <http://www.defra.gov.uk/news/latest/2007/climate-0620.htm>, last accessed 12.11.2008; <http://www.tesco.com/climatechange/carbonFootprint.asp>, last accessed 12.11.2008.

considers the polluter pays principle (PPP), developed by the OECD in the 1970s, as the basis for full cost accounting:

The rationale for full cost accounting can be illustrated with reference to an extension of the polluter pays principle (PPP) to the domain of accounting. (Atkinson, 2000: 240)

This PPP is, to all intent and purposes, a statement that externalities ought to be internalised (Edwards-Jones *et al*, 2000). However, full cost accounting not only deals with the externality borne by society from pollution emissions but also the *internal* costs already borne by the firm itself but not measured and/or not attributed to respective productive activities (Bennett and James, 1999). Thus, I would contend that full cost accounting is more than a mere extension of the PPP.

The analysis of these intra-firm costs is different to the analysis of externalities. The latter might include social costs as well as environmental costs. There is an extensive literature on the broad social consequences of production (e.g. Korten, 1995; Martinez-Alier, 2004; Klein, 2002) but less by way of implementation vis-à-vis the valuation of the social externalities at the margin. The over-arching critique of the anti-corporate school is that the scale of TNCs and their associated power in the socio-political environment is in itself destructive. It is unlikely then that firms that seek growth, market share and market dominance will sign up to any accounting schemes that are based on a fundamentally antagonistic agenda, *viz.* anti-globalisation. Kolk (2000) also discusses the 'paradox of information': the more open a firm is about its environmental and/or social practices, the more it is open to scrutiny and criticism and the more is demanded of it vis-à-vis commitments to provide information. Thus the omission of social accounting from CGS is pragmatic.

Turning to environmental externalities, Atkinson (2000) presents the argument that these environmental costs might be considered liabilities in conventional accounting terms. He correctly notes that such a liability should be estimated by multiplying the marginal damage cost of the pollution by the number of pollution units. The author uses such unitary damage values to estimate the value added by industry sector, *viz.* the contribution to national income net of the environmental costs borne by society attributable to that sector. There is also an analysis of CGS for the electricity generator Powergen. Genuine savings in a corporate sense is the net profit minus the damage values estimated for its production. One criticism I would make of such analyses is that, although rigorous, the resultant outcomes must be interpreted with care. For instance, with reference to the Powergen example, Atkinson (2000) writes:

According to the 'bottom line' CGS rate, the sum of the damage exceeds profits in the years 1992 through to 1995. In other words, on our definition of sustainability, the company appears to have been behaving unsustainably during this period. (Atkinson, 2000: 247)

Although Atkinson does to an extent discuss the sharing of responsibility for the 'blame' between producers and consumers earlier in the paper (Atkinson, 2000:241), I would argue that the attributing of responsibilities is of paramount importance in the discussion of sustainability of the electricity generator: the electricity supplied to other industry sectors is a type of *intermediate* resource input and thus it is the *embodied energy* in final products that should, in part at least, be attributed to the pertinent industry sectors.

CGS appears to be an interesting methodology in that it provides a monetised account of a firm's externalities in absolute terms but its application to date has been limited. The next three sections consider novel methods to determine the *relative* performance of firms within an industrial sector, *viz.* eco-efficiency, DEA and SVA. Unlike CGS, none of these methods relies upon environmental impacts being monetised.

4.3.4 Eco-efficiency

The most commonly known type of relative measure is, according to Figge and Hahn (2004), eco-efficiency. It is an indicator which assesses economic and environmental (but not social) performance in an aggregated manner, without monetising impacts, yielding a single composite value. Its application has been given impetus by the World Business Council for Sustainable Development (see Verfaillie and Bidwell, 2000):

The WBCSD defines eco-efficiency as being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity. (WBCSD, 2004)¹⁹

The indicator is defined as the ratio of Economic Value Added/Environmental Impact Added. As such it relates to both DEA and SVA. Value added is turnover minus the costs paid by the firm for goods and services purchased (Figge and Hahn, 2004), i.e. a firm-level equivalent to the industrial value added calculated under the output approach in macro-level national income accounting (Edwards-Jones *et al.*, 2000). The environmental impact added is the aggregate of natural resource and energy flows associated with the production weighted with respect to their impact on given environmental theme areas. The methodology for inputting the environmental impact borrows from LCA. Eco-efficiency is not conceptually dissimilar to such macro indicators as the ecological rucksack (the weight of natural resources used to produce a given

¹⁹<http://www.wbcsd.org/templates/TemplateWBCSD4/layout.asp?type=p&MenuId=NzA&doOpen=1&ClickMenu=LeftMenu>, last accessed 22.06.2008.

output) and the EF. Further, satellite national income accounts similarly categorise environmental emissions with respect to theme areas, e.g. ozone layer depletion, climate change and acid rain for the UK accounts (Bryant and Cook, 1992). Thus I would argue that eco-efficiency is not a novel concept but one very much grounded in tried-and-tested methodologies.

Eco-efficiency has become a dominant paradigm in the greening of industry, spawning influential concepts such as 'Factor 4', *viz.* doubling output and halving resource use. As such, eco-efficiency does have its critics. Hukkinen (2001) criticises eco-efficiency as being an 'abandonment of nature'.

[eco-efficiency] indicators ought to serve the more general goal of building local level governance systems for ecosystem management, characterized by locally designed and maintained institutions and conflict resolution mechanisms. (Hukkinen, 2001: 314)

The humanist position that Hukkinen adopts is one that borrows from the 'Small is Beautiful' school of Schumacher (1973). As such, it is incompatible with the world-view of environmental change through *global* institutions, be they corporate or otherwise. It would appear that the only way to make a conventional, post-globalisation concept like eco-efficiency compatible with this humanist perspective would be to expect firms to be advocating their own demise. A more credible critique of eco-efficiency is presented in Figge and Hahn (2004). First, they argue that the very relativity of the measure inherently fails to capture the absolute magnitude of problems.

If e.g. it is common knowledge that a company produces 4E [Euros] value per ton of CO₂, one can neither tell how much value the firm created nor how much CO₂ it emitted in absolute terms. (Figge and Hahn, 2004: 177)

Although unequivocally correct, I would argue that it is the *relative* environmental performance of the firm that is of paramount importance. The second critique made is related to auxiliary effects of improved eco-efficiency that, the authors claim, might imply that any benefits might be 'over-compensated':

On the one hand, a better eco-efficiency might lead to growth and thus an increased use of environmental resources (rebound effect)...On the other hand, environmental resources which are saved due to improved eco-efficiency might be employed by other companies which are less eco-efficient (Figge and Hahn, 2004: 177)

Both these elements of the critique are linked. My refutation of this critique is derived from the fundamental theorems of welfare economics, *viz.* any resource allocation arising from a well

functioning market is *de facto* a Pareto efficient outcome (Cowell, 1996). The very definition of economics is that of a discipline concerned with the optimal allocation of resources in society. In this sense, the authors are being ‘uneconomic’. The ‘pure economic’ role of the state, as discussed in Chapter 2, is to ensure that markets function efficiently so as to allow consumer sovereignty. The corollary of the argument of Figge and Hahn above is that we should stimulate and embrace *inefficiency* (or at the very least add a further criterion than efficiency). What they imply is a ‘Second Best’ solution to the problem of resource over-exploitation and environmental sink degradation. A ‘First Best’ alternative is simply to set out-and-out environmental constraints.

Consider the example that Figge and Hahn (2004) present to illustrate how an increase in eco-efficiency can lead to decreasing eco-effectiveness. Their two-period model (t_0 , t_1) has one single firm: in period t_0 and t_1 the economic value added is 4 Euros and 10 Euros respectively and environmental impact added is 8 and 10 units respectively. The eco-efficiency has increased from a ratio of 0.5 (4/8) to 1 (10/10) but the economic growth that has stimulated this shift is deemed to have had a negative overall impact on the environment (i.e. $10 > 8$). The authors’ analysis implicitly assumes that *ceteris paribus* conditions apply, i.e. in the industrial domain the increase in value added between t_0 and t_1 has occurred in isolation without any consumer *substitution* across products. In order to illustrate the importance of this assumption, the model might be reapplied with two firms. Let the firm in the Figge and Hahn (2004) model be termed F_A and a second F_B . Assume for simplicity that the market structure is a duopoly and that each firm produces the (heterogeneous) product with equal eco-efficiency in period t_0 : total industry value added in t_0 is 10 Euros, i.e. a split of 4 Euros and 6 Euros respectively, and total industry environmental impact added is 20 units, i.e. 8 units and 12 units respectively. If F_A and F_B were to merge in period t_1 , it might plausibly be assumed that the industry value added stays constant (10 Euros) but that the environmental impact of the merged firm is lower at 10 units than the aggregate in t_0 , i.e. 20 units. In this case it is unequivocally the case that the environment has benefited. A retort from Figge and Hahn to this alternative two agent model might be that the outcome depends on relaxing the (implicit) condition of their single agent model in permitting consumer substitution. (In my illustration this is a substitution brought about by the creation of a monopoly in t_1 but this is not a necessary condition for the applicability of the model.) But the point is that substitution is a real world phenomenon. This substitution is not isolated to intra-industry effects but also applies cross-industry. Reconsider the Figge and Hahn (2004) model and my re-illustration above. F_B might actually be a firm in another industry altogether. If consumers substitute away (entirely in this case for ease of exposition) from F_B to F_A in t_1 then once more the total environmental impact at t_1 is lower *in*

absolute terms even though the Figge and Hahn (2004) assumption of a single firm model is retained.

A third critique by the authors is the lack of social context to eco-efficiency. They do accept that it is "very doubtful" that environmental and social indicators might all be integrated, therein perhaps providing a pragmatic retort to their own critique (Figge and Hahn, 2004:176).

SVA (Figge and Hahn, 2004) unto itself is a novel and noteworthy development in the sustainability indicator literature and I review and critique the approach in Section 4.3.6. I discuss DEA first as this method pre-dates SVA and there are methodological parallels between the two. However I would argue that the criticism that the authors make of eco-efficiency as a methodology is on occasion misplaced.

4.3.5 Data Envelopment Analysis

DEA is a form of input-output modelling that draws on the analytical framework of the production possibility frontier (Callens and Tyteca, 1999). A given production output might be produced using different levels of environmental impact - natural resource input and pollution emission. The efficiency frontier is the production technique that minimises impact for any given output. This analysis is relative: once this frontier is defined, the relative inefficiency of techniques not on the frontier might be estimated. Callens and Tyteca (1999) acknowledge that, if observed production techniques are inputted, these frontier points may not be sustainable in absolute terms. The strength of DEA modelling is that there is a clear standardisation in that all units are ranked according to a scale wherein 1 represents best practice for that element. The many economic, environmental and social attributes are not weighted *per se*; DEA methods select the weight combination that minimises the distance from the observation to the frontier, which is thus the most favourable combination possible.

This methodology leads to outcomes that are technically efficient but only owing to their being 'best performance' for one (and only one) attribute. For instance, the outcome that maximises 'turnover' is efficient irrespective of the performance of this outcome vis-à-vis other attributes, be they social, environmental or economic. The analytical framework applied is in some respects similar to the quasi-Pareto approach of Feindt (2000). This drawback might be overcome through the imposition of relative weights to different attributes. Although this may be somewhat arbitrary, it is clear that resource constraints vary both spatially and temporally and I would argue that some compensation should therein be made. There is certainly some methodological strength in DEA but applications to date have been limited (e.g. Haynes *et al.*, 1994 consider chemical plants; Fare *et al.*, 1996 consider fossil-fuel energy generation).

4.3.6 Sustainable Value Added

Figge and Hahn (2004) develop an indicator which the authors term Sustainable Value Added (SVA). SVA is an indicator that aggregates multiple (quantified) impacts into a single, non-weighted composite. It is a novel hybrid approach in that it is simultaneously a relative and an absolute measure: it is relative in the sense that it accounts for resource efficiency and the environmental profile of emissions measured against a sector-specific benchmark but these results are then juxtaposed with absolute resource use. The key feature of the SVA approach is the conceptualisation of *opportunity cost* vis-à-vis exploitation of the natural environment whilst accounting for the firm's output: "the size of the contribution of a company to more sustainability measured in monetary terms" (Figge and Hahn, 2004, p.177). Figge *et al.* (2008) apply the methodology to determine the SVA of car-manufacturers.

There are various methodological limitations, some of which are acknowledged by the authors whilst others are not. Included in the former category is the fact that the SVA is a cradle-to-gate approach, therein drawing a system boundary that excludes the sustainability impacts of suppliers and consumer use/disposal (Figge *et al.*, 2008). In the latter category of criticisms I would contend that the implicit equal weighting afforded each impact category is misguided; any non-uniform weighting applied will be industry-specific and contentious but I would *argue* that the concomitant error arising is preferable to the blanket rejection of weighting. A solution is to fall back upon relative values generated by extant valuation literature (as per CGS) but the authors reject this approach (Figge and Hahn, 2004).

4.4 Chapter conclusions

The paradigm of sustainable development has become firmly established both in the policy-making domain and in academia. This chapter briefly sketches the development of the paradigm and in so doing shows that momentum with respect to the evolution of the concept and its insinuation into the political milieu arguably peaked in the early 1990s with the Rio Earth Summit. The transposition of the sustainability concept into evaluative tools has developed in the main since this time, although systems dynamics models captured public attention well before the Earth Summit (e.g. Meadows *et al.*, 1972; Ehrlich and Holdren, 1971). Recent surveys have attempted to chart this development (e.g. Mayer, 2008; Bohringer and Jochem, 2007). Many of the fundamental issues that pertain to quantitative multi-dimensional sustainability indicators in general (e.g. data integrity; comparability across indicators; aggregation of individual indicators into indices versus non-aggregated frameworks) apply as much (if not more) to industrial sustainability measurement.

With regards tools to evaluate industrial transformation towards sustainability I would argue that a distinction needs to be made between developments in the academic literature vis-à-vis sustainability *indicators/indices/frameworks* and the consensus position in industry (as indicated by uptake) which is the dominance of sustainability *reporting*, the latter being driven forward by the GRI. Broadly speaking reporting is characterised by a ‘checklist’ system focused more on management *processes* than sustainability performance *per se*. One outcome of this focus is that there is a proclivity for firms that are well-resourced and/or have a incentive to promote themselves as sustainable to report. The latter category contains not only firms that are genuinely committed to sustainability but also others that merely wish to convince stakeholders/regulators of their sustainability credentials. This is a core theme of this research overall with respect to eco-labelling.

The data collected as part of the GRI have however contributed to developments in the academic domain vis-à-vis measuring corporate sustainability. Eco-efficiency as a broad conceptual framework has insinuated into industry (WBCSD, 2004²⁰) but only in a prosaic form, viz. the high-level *aspiration* (as opposed to commitment) to reduce resource use whilst improving productive efficiency. Eco-efficiency as a distinct methodology (as opposed to a ‘way of thinking’) is defined as the ratio of Economic Value Added/Environmental Impact Added. It is consonant with (and to an extent borrows from) both national income accounting and LCA frameworks.

There are broad conceptual similarities between eco-efficiency and both SVA and DEA. I would argue that both the latter methodologies have much to offer with regards indicating environmental sustainability: they are based on a process of benchmarking; they each manipulate datasets that are in the main externally verified; they link the analysis of environmental impact back to financial performance; they are uni-variate measures; and there is the potential to apply benchmarking to more socio-economic criteria. However the mechanism by which the methods collapse the multi-dimensionality of environmental sustainability into a uni-variate measure is, I would argue, inappropriate, viz. each attribute is afforded an equal weighting. Figge and Hahn (2004) are explicit about the rationale for this with regards SVA: the contentiousness of environmental valuation. The trade-off here is between the error inherent in valuation methods versus systemic error arising from assuming that all attributes are equally as influential in determining industrial sustainability. I would err on the side of error in preference to abstaining from the issue altogether.

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<http://www.wbcsd.org/templates/TemplateWBCSD4/layout.asp?type=p&MenuId=NzA&doOpen=1&ClickMenu=LeftMenu>, last accessed 22.06.2008.

In this respect CGS is preferable to SVA and DEA in that environmental impacts are monetised but the solution afforded is only partial in the following respects: only a small sub-set of environmental impacts is estimated owing to a paucity of environmental valuation studies; there is no industry-level benchmarking *per se*; and analysis is at the firm level as opposed to product level, therein implying that larger firms are likely to perform better in terms of CGS.

One issue with regards all four of the uni-variate indicators discussed above is the extent of their application; in all cases there are select few case studies therein implying that their direct impact on green consumerism has been limited. In this regard CEF is markedly different. A distinction has to be made with regards EF analysis and the carbon footprint; tools to apply the latter are widely available, linked to the principle of carbon offsetting. The EF is more complex in that all environmental impacts are collapsed into a non-monetised measure (gHa). EF is actually a family of methodologies that apply different approaches (i.e. component, composite and input-output) and which are developing rapidly in response to methodological criticisms and data availability. Each attempts to juxtapose anthropogenic environmental appropriation with biocapacity. Some of these criticisms include variability in results derived from competing LCA databases in component EF (Bouazzaoui *et al*, 2007), the link between expenditure data and impact in input-output EF and more broadly assumptions regarding carbon sequestration potential (Kitzes *et al*, 2007; Lenzen and Murray, 2003) and unproductive/multi-functional land (Moffatt *et al*, 2001). Perhaps the most damning criticism of EF at corporate level is the fundamental inability to assess corporate sustainability in absolute terms owing to the fact that there is no biocapacity equivalent for single firms. However I would contend that, despite this, the EF has the most to offer in terms of 'operationalising' corporate sustainability as the EF does allow benchmarking and does capture the multi-dimensionality of industrial environmental sustainability in a uni-variate measure. Further there are different composite elements to the EF (e.g. sea footprint, pasture footprint *etc.*) that (unlike SVA/DEA) are not given equal weighting. Thus the approach not only seems sensible but there is also some momentum to its development and application.

In overall summary, I would suggest that corporate environmental impact is difficult to measure but there are extant approaches that have attempted to do so. The core question with respect to how this chapter impinges on the overall research is as follows: are there methodologies that can be applied to measure the impacts of industrial production? The answer is that there are, but that all are methodologically contentious. If the answer were to have been that no extant methodology is fit for purpose then it would be difficult to progress the argument, *viz.* should

corporate behaviour with respect to environmental impact be modified through regulatory intervention, and if so what determines optimality.

5 AN ECONOMIC EVALUATION OF THE PORTER HYPOTHESIS

5.1 Introduction

The PH might be summarised as follows: well-designed stricter environmental legislation applied to industry will stimulate benefits in terms of cost savings and competitive advantage that offset the compliance costs; the reason that this applies is that firms only search for eco-innovations if so pushed (Porter, 1991). The PH is a key theoretical linchpin to this research in that many of its assumptions are explored, *viz.* behaviour vis-à-vis eco-innovation adoption (Chapters 6 and 7) and demand-side shifts that are stimulated by green consumerism (Chapter 8). The PH also presumes that the current rate of eco-innovation adoption is both measurable and insufficient and therefore requires regulatory intervention; this was explored in Chapter 4. It is also premised on the worldview that firms' responses to these interventions are profit-driven as opposed to CSR-motivated, a premise that talks to the discussion in Chapters 2 and 3.

The role of this chapter is not only to contextualise the research with respect to the PH but also to make a distinct contribution to the PH analysis by arguing that the focus on whether or not private win-win outcomes arise (i.e. offsets exceed compliance costs) fails to account for the expected social benefits that arise. These benefits occur as regulation necessarily takes place in under conditions of uncertainty and asymmetric information wherein the two agents (the regulator and the regulated) do not share identical information sets. What I demonstrate is that, under these conditions, offsets exceeding compliance costs remains a sufficient condition for the efficiency of stricter legislation but is no longer a necessary condition; the revised conditions are set out.

The structure of the chapter is as follows: Section 5.2 reviews and critiques the extant PH literature; Section 5.3 models the PH under conditions of certainty; Section 5.4 models the PH under conditions of uncertainty and asymmetric information; Section 5.5 sets out chapter conclusions.

5.2 The Porter Hypothesis: theoretical constructs and empirical evidence

Regulation is not a one-way process where the state applies rules and firms comply: industry lobbies to try to influence the type, content and timing of regulation. Further, firms and industry organisations can choose to set up voluntary environmental performance schemes, an example being the Responsible Care Programme in the chemicals industry discussed in Chapter 7. Such initiatives might be spurred by a CSR agenda but equally they might be a pre-emptive strategy to avoid the application of (and compliance costs associated with) mandatory environmental

regulation. Tradition textbook economic theory (e.g. Pearce and Turner, 1991) suggests that regulation imposes an economic burden on firms; this is the reason that such pre-emptive strategies are adopted. However, if such regulation serves to internalise a pollution externality at least-cost then it is economically efficient. Porter (1990) presents a controversial and opposing worldview that has been developed further (e.g. Porter, 1991; Porter and van der Linde, 1995a; Porter and van der Linde, 1995b).

A conventional neo-classical economic defence of regulation would require an evaluation of the *social* costs and benefits of environmental policy as described above. The arguments that Porter and van der Linde (1995b) present are premised on their perceptions of the failure of economic modelling in that it is argued that it has a 'static' focus:

[T]his static view of environmental regulation, in which everything except regulation is held constant is incorrect. If technology, products, processes and customer needs were all fixed, the conclusion that regulation must raise costs would be inevitable. But companies operate in the real world of dynamic competition, not in the static world of much economic theory. They are constantly finding innovative solutions to pressures of all sorts – from competitors, customers and regulators. (Porter and van der Linde, 1995b:133)

According to the authors win-win situations appear to be ubiquitous so long as regulation is appropriately designed. For many policymakers (e.g. Gore, 1992) this appeared to be a panacea in that, if empirically valid, it relieved them of the politically and socially difficult trade-off between environmental and economic targets.

The *ceteris paribus* condition inferred in Porter can be a limitation of economic modelling. The 'fallacy of misplaced concreteness' is discussed at some length in Daly and Cobb (1991) for instance, where they develop the analysis of Whitehead (1925). This concerns the 'mathematisation' of economics as a discipline: models are 'concrete' in the sense that they are mathematically rigorous but the abstractions required (assumptions made) are so limiting that the outcomes should not be used for real-world decision-making, but often are. However, I would argue that the criticism of 'static' analysis *per se* is imprecise: comparative statics can capture their argument adequately, as presented in the next two sections.

The PH has spawned a large associated literature (e.g. Xepapadeas and deZeeuw, 1999; Heyes and Liston Heyes, 1999; Farrow and Toman, 1999; Heyes, 1998; Golombek and Raknerud, 1997). Although there are many expositions of pollution control theory in general, only and Mohr (2002) and Xepapadeas and de Zeeuw (1999) focus on the PH in particular, i.e. offsets and private optimality conditions. Mohr (2002) uses a general equilibrium model that allows for the introduction of new technology. A feature of this technology is that, although it

realises long term cost reductions, it implies a short term cost penalty. The model shows that there is then a first-mover disadvantage and a second-mover advantage. This outcome is resonant with Arthurian lock-in (Arthur, 1989) discussed in the next chapter. Xepapadeas and de Zeeuw (1999) develop a model of capital stock modifications arising from the application of an emissions tax. The introduction of the emissions tax leads to changes in productivity and profitability in the model. The model assumes that newer capital stock has higher productivity, lower running costs and emissions that are no higher *ceteris paribus* as compared with the older stock. They also assume a market for the older stock and that the tax is levied on all machinery. Under these assumptions, the tax increases productivity and lowers emissions but at the expense of profitability. However, in practice existing capital stock is often exempted from stricter environmental legislation, in which case the outcomes of the model no longer apply, a point made by the authors themselves.

There is a significant body of empirical evidence supporting the PH but largely based on individual case studies. Apart from the examples cited in Porter and van der Linde (1995a), the US Environmental Protection Agency website²¹ documents some such ‘win-win’ scenarios. Other examples include papers from the Environmental Law Institute²² and the analysis of the CFC market post-regulation in Albrecht (1998). However, the problem of determining the extent to which such studies are representative remains. On the other side of the argument, Rutledge and Vogan (1994), cited in the Palmer *et al.* (1995) retort to the Porter and van der Linde (1995a) paper, provides case study evidence to show that compliance can and does incur net costs to the firm. Rutledge and Vogan (1994) use figures from the Bureau of Economic Analysis which estimated the environmental spending in the US in 1992 to be around \$102 billion. The figure for cost offsets derived by the Bureau of Economic Analysis for 1992 was just \$1.2 billion, under 2 per cent of total costs.

Jaffe *et al.* (1995) examine one aspect of the PH, *viz.* the effects of stringent environmental legislation on US exports. They report that these effects are quantitatively small and statistically insignificant with respect to US exports to Mexico. They argue that, although there is evidence of migration of polluting industries from developed world nations with more stringent environmental legislation to developing world nations, the effect on economic development have been small. This proposition is echoed by World Trade Organisation (2002). Tobey (1990) examines the correlation between the stringency of environmental legislation and the value of net exports across different countries and finds there to be no significant correlation. Grote and Delitz (2000) carry out a comparative study of the production of vegetable oils, grain

²¹ <http://www.epa.gov/p2/docs/p2case.txt>, last accessed 11.06.2008.

²² <http://www.eli.org/store/r99innovation.html>, last accessed 11.06.2008.

and broiler chicken for Brazil and Germany. They report that the marginal environmental compliance costs associated with stricter legislation for the latter were relatively small and insignificant in determining international competitiveness. A synopsis of this position is provided by Roediger-Schulga (2001) who investigates the impact of Volatile Organic Compound legislation on Austrian firms:

These results match the findings of other empirical studies that actual environmental regulation appears to have little economic impact....some firms may benefit and others may suffer, but the large majority will remain virtually unaffected. (Roediger-Schulga, 2001: 18)

The literature on the greening of industry is populated with didactic, sweeping titles that are intended to convey emphatically and unequivocally the notion that 'win-win' situations are omnipresent, e.g. Elkington, 1994²³; Shelton and Shopley, 1996). There are various causes for this didacticism. First, there are the norms and values of the researchers. Second, the use of 'best case' studies is also linked to the fusion between 'pure' academic research and consultancy activities that is a feature of analysts in this field; a firm contemplating external consultancy is more likely to hire a consultant with a positive track record of 'win-win' achievement. Third, there is a form of systematic bias at play vis-à-vis the selection of the firms analysed: firms that are leading edge eco-innovators are more likely to be receptive to and accessible to researchers. Fourth, the analysis of a non-event, e.g. a firm choosing *not* to implement an environmental management system, is perhaps less academically engaging. Further, such firms are less likely to respond to surveys either because they are defensive or because the firm does not consider that their production impacts on the natural environment.

For these various reasons, a reading of the green management literature would leave the overriding impression that there is still 'low hanging fruit' to be picked vis-à-vis 'win-win' scenarios. Schot and Fischer are representative of this didacticism:

new ['green'] markets will become more articulated and visible...existing competitors or new firms will innovate and gain competitive advantage. (Schot and Fischer, 1993:14)

This type of didacticism might be challenged. For instance, the 'win-win' case studies in North (1992) concern inherently environmentally-sensitive manufacturing processes: mercury and cadmium-free battery manufacture; polyethylene fencing manufacture using recycled resins; Swedish anti-air pollution device manufacture.

²³ <http://www.johnelkington.com/TBL-elkington-chapter.pdf>, last accessed 10.09.2009.

The analysis of the literature on the validity or otherwise of the PH is inconclusive. Since environmental abatement as a proportion of total industry expenditure is (in most cases) small anyway, the effect of marginally more stringent legislation is bound to be smaller still. This implies the main problem in testing the PH on a macro scale, *viz.* statistical noise in the system. What an econometric analysis seeks to achieve is the isolation of the effects of one change (stricter environmental legislation) on overall competitiveness. The latter is a moving target and the former has a small overall impact on the latter.

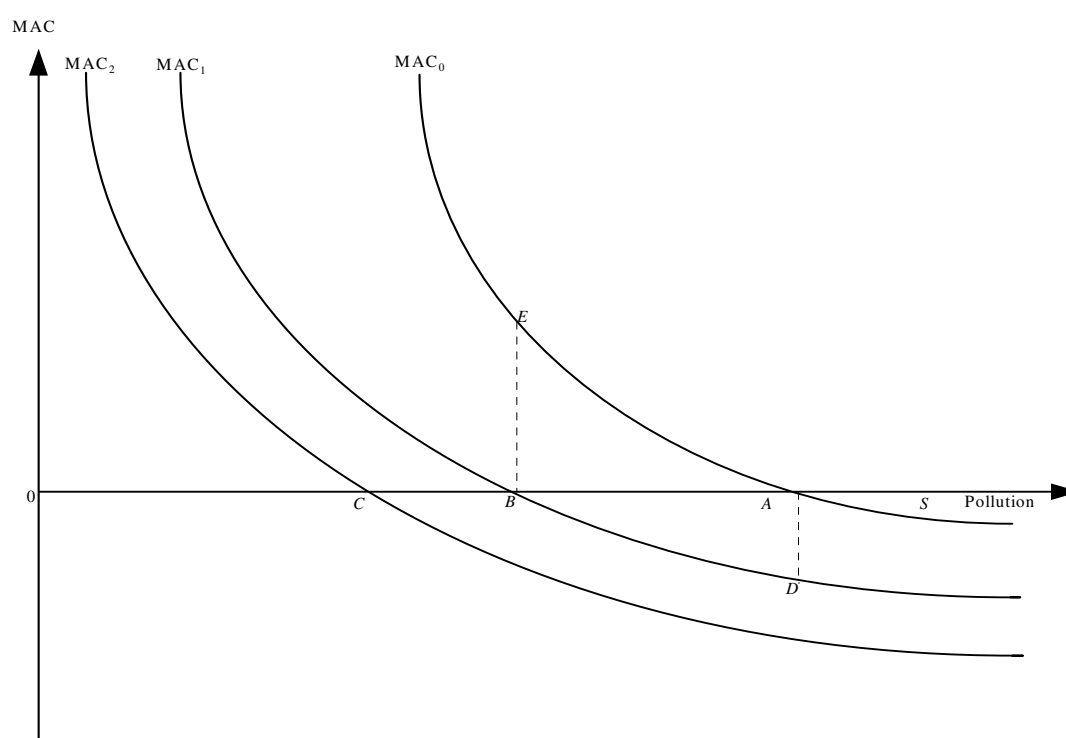
5.3 A baseline economic model of the Porter Hypothesis

Consider Figure 5. It is conventional in that the Marginal Abatement Cost [MAC] curves are downward-sloping (Pearce and Turner, 1991). However, Figure 5 breaks from economic convention in two ways: first, there is more than one MAC curve drawn for the same polluter; second, there is a segment of each MAC curve that lies below the horizontal axis. The definition of the MAC curve might be the locus of points that give the true private cost (net of benefits) to the polluter of abating any one incremental pollution unit given the institutional framework and information set under which the polluter operates. If this definition is adopted then Figure 5 captures the aforementioned ‘static’ criticism of Porter and van der Linde (1995b) as any of these variables might change, causing a shift in the MAC curve.

If the *status quo* is that pollution is at level S in Figure 5 then the MAC is negative. Under conventional economic analysis, such a statement would be treated as true but irrelevant in that a firm would not choose to pollute at a level that is higher than the private optimum (A for MAC_0). However, if there is a discrepancy between the firm’s perception of MAC and *true* MAC then it is indeed conceivable that the firm might choose level S . S might arise because the firm overestimates abatement costs and/or underestimates the *benefits* from abatement. Indeed, it may occur because the firm simply does not expend the transaction costs in evaluating MAC at all. These benefits might arise for instance from green consumerism, reductions in insurance liabilities for environmental hazards, or indeed the ‘learning by doing’ as a type of intra-firm investment²⁴.

²⁴ Chapter 6 discusses this shift in considerable detail. The firm might be ‘satisficing’ (Simon, 1959), i.e. inertia in eco-innovation adoption owing to the fact that the firm is sufficiently profitable. Further, the firm’s ‘history’ of innovation adoption might imply that pollution offsets are not ‘searched for’ and ‘selected’ (Nelson and Winter, 1982).

Figure 5 Marginal Abatement Cost curves under changing information sets



MAC_0 applies to a given institutional framework, information set for the firm, *viz.* the “technology, products, processes and customer needs” that Porter and van der Linde (1995a) refer to. A shift in these conditions implies a shift in the MAC curve that applies, say from MAC_0 to MAC_1 or to MAC_2 therein shifting the private optimum for the firm to B and C respectively. Once this MAC shift has occurred, the *ex ante* optimum is no longer the privately efficient choice for the firm. For instance, at A the MAC is negative (D) once the MAC shifts to MAC_1 from MAC_0 . Conversely, pollution level B implies a high private abatement cost (E) to the firm given MAC_0 but is the private optimum given the shift to MAC_1 . The analysis in this section has considered the PH with respect to shifts in the private optima alone. Section 5.4 continues the theoretical development by considering the social welfare consequences of shifting MAC curves under conditions of asymmetric information between the firm and the regulator.

5.4 The Porter Hypothesis and asymmetric information

The PH itself concerns itself with the *private* welfare of the firm. The critical contention in the PH is the private benefits realised by the firm from pollution offsets exceed the private compliance costs of stricter regulation. In conventional economic terms, it is optimal for the state to regulate so as to internalise pollution externalities, increasing *social* welfare by so doing. Porter and van der Linde (1995a) do not discuss social optimality *per se*. The framework

presented here considers shifts in pollution abatement technologies and/or techniques that imply a shift in the costs to the firm of abating pollution. Palmer *et al* (1995) in critiquing the PH do not contend that these shifts (pollution offsets) are non-existent - only that they are *overstated*. An important issue that has not been analysed sufficiently in the literature is the effect that these pollution offsets have on the privately and socially optimal level of pollution emissions: I demonstrate that (given certain assumptions) the social and private optima converge. This is an important result for policy makers, as the real world application of regulation occurs under conditions of uncertainty vis-à-vis the costs and benefits of pollution reduction. Under such conditions of uncertainty, there is typically a strategic incentive for the profit-maximising polluter to exaggerate pollution abatement costs to the regulatory authority; if such 'cheating' (in the strategic behavioural sense) is successful then the aggregate abatement costs for the polluter are reduced and the pollution emissions level is higher *ceteris paribus*. This argument then modifies the debate concerning the empirical validity of Porter's contentions. Without paying due regard to this argument, the pollution offsets must exceed the firm's abatement costs for the more stringent legislation to be economically optimal. I argue that the optimality condition should be restated so that the abatement costs are less than the sum of pollution offset benefits *plus* the expected benefits of the avoided social welfare loss arising from the nature of the regulatory process, i.e. the divergence between the firm's information set and that of the regulator.

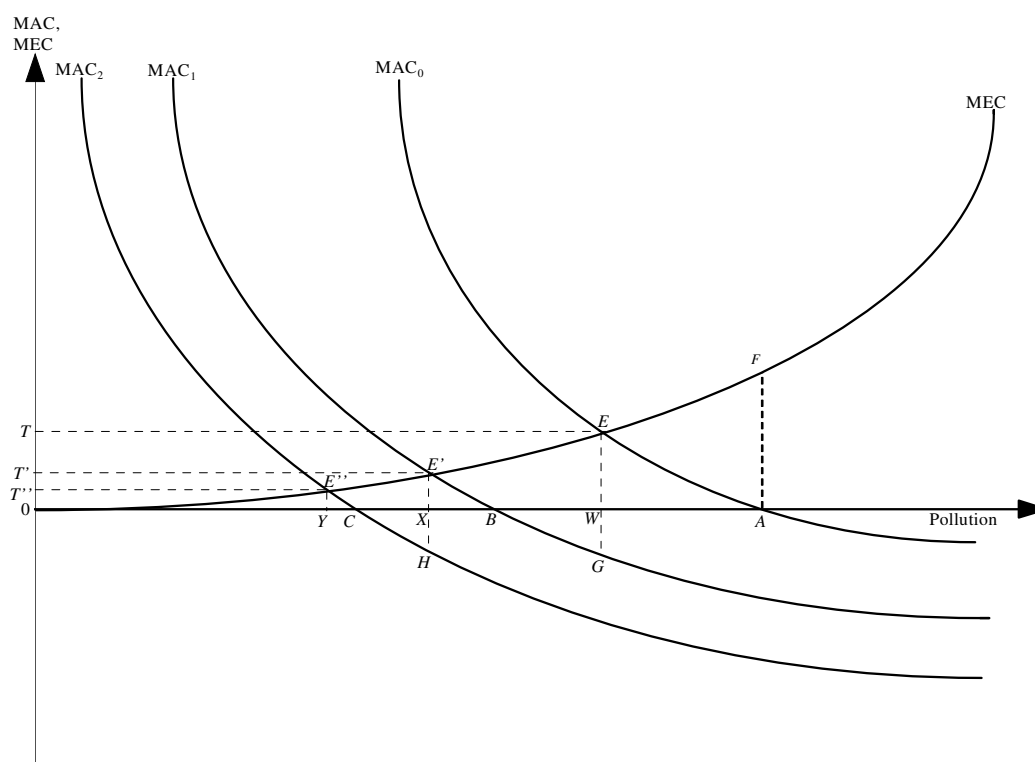
The rest of this section builds up the optimality narrative in progressive steps. In Section 5.4.1, I start by conceptualising the PH in terms of the standard environmental economic analysis of welfare under conditions of complete and perfect information with an instantaneous shift in the MAC curve. The analysis in Section 5.4.2 maintains the simplifying assumption of an instantaneous MAC shift but under arguably more realistic conditions of asymmetric information, i.e. the firm knows the location of the *ex post* MAC curve with certainty whereas the regulator does not. The final dimension of time, i.e. the shift in MAC is no longer assumed to be instantaneous, is discussed in Section 5.4.3. In each of these three cases optimality conditions are set out, i.e. how substantive the benefits would need to be to offset the costs of achieving the MAC shifts, the latter being the transactions costs and implementation costs for the adoption of greener production practices.

5.4.1 Optimality conditions: perfect and complete information

Consider Figure 6. The MAC curves from Figure 5 have a MEC curve superimposed on them. MEC is the aggregate incremental cost to all agents bar the polluter of a unit of pollution. MEC is assumed to increase with pollution levels. For MAC_0 , MAC_1 and MAC_2 the social optima are given by OW , OX and OY respectively. Three social optima occur in Figure 6 owing to there

being three MAC curves; there will only be one social optimum at any given point in time as there is only one pertinent MAC curve at any given time. These different MAC curves pertain to different institutional frameworks and information sets for the firm as discussed above. Since the MEC curve is determined by society's evaluation of the pollution hazard, there is no obvious reason why shifts in MAC should imply shifts in MEC *ceteris paribus*.

Figure 6 Social and private optima convergence under shifting MAC curves



As per standard NC theory (e.g. Edwards-Jones *et al.*, 2000), the private optimum occurs where the MAC curves intersect the horizontal axis. This principle applies for each iteration, i.e. for each shift in MAC curve. Figure 6 as drawn shows OB and OC , i.e. the private optima after the first and second MAC shift iterations respectively, to be left of OW , the initial social optimum. This need not be the case; their positions are dependent on the scale of the gains achieved. Figure 7 shows a less radical shift in MAC curves. However, the social optima resulting from the first and second iterations (OX , OY) are necessarily to the left of OW , i.e. the initial social optimum. Although the private optima (OB , OC etc.) from the next iterations might 'overshoot' the initial social optimum OW , they are always strictly to the right of the new associated social optima (OX , OY etc.) corresponding with the iteration. Thus there is no inference that the private optimum can be a *lower* level of pollution than the social optimum as this would be erroneous. It is thus conceptually important to distinguish between iterations in the analysis. In Figure 6,

after the first iteration (i.e. the shift from MAC_0 to MAC_1) the marginal abatement cost at the *ex ante* social optimum (OW) is negative (i.e. WG). The same applies to the second iteration from MAC_1 to MAC_2 , i.e. XH . Note that this situation will not apply under a less radical shift in MAC curves. Further, the private optima at OB and OC occur *after* a change in conditions – the institutional framework and/or the information set of the firm. OA was the initial private optimum given the initial conditions; just because OB or OC is ‘right’ for the firm *ex post* now does not mean that OA was ‘wrong’ *ex ante*. The same argument applies to the social optima.

Under conditions of perfect and complete information, optimal regulatory intervention implies shifting the permissible pollution threshold to the new social optima at OX and OY in Figure 6 after the first and second iterations respectively. This might be achieved through a shift in the Pigovian tax rate from OT to OT' after the first iteration and OT'' after the second. However this is an incomplete analysis, even under the restrictive conditions of perfect and complete information, since we need to consider how such a shift in MAC curves might arise and the associated cost implications. As outlined above, MAC curve shifts arise from changes in the institutional framework and/or the information set of the firm. The issue of what stimulates the search for and adoption of eco-innovations is expounded in the two chapters that follow. What is important to note at this stage of the analysis is that there are likely to be private costs borne by the firm associated with such shifts in MAC curves. The question that arises is whether the firm would choose to expend such costs voluntarily without the ‘stick’ of more stringent environmental regulation that the PH contends is necessary.

Figure 7 is similar to Figure 6 but, for ease of exposition, only one MAC curve shift is shown, viz. MAC_0 to MAC_1 . In Figure 7, under conditions of certainty, the regulator would choose the pollution level OX *ex post*²⁵. There are three effects on social welfare arising from a reduction in pollution from OW to OX . First, there is a reduction in the external costs borne by society owing to the pollution; this is the area under the MEC curve, i.e. $XGEW$. Second, the increased abatement costs borne by the firm in reducing pollution from OW to OX ; this is the area $XGFW$. Third, there is the welfare gain, both private and social, of the reduced abatement costs borne by the firm for pollution units OA through to OW ; this is the area $HFEA$.

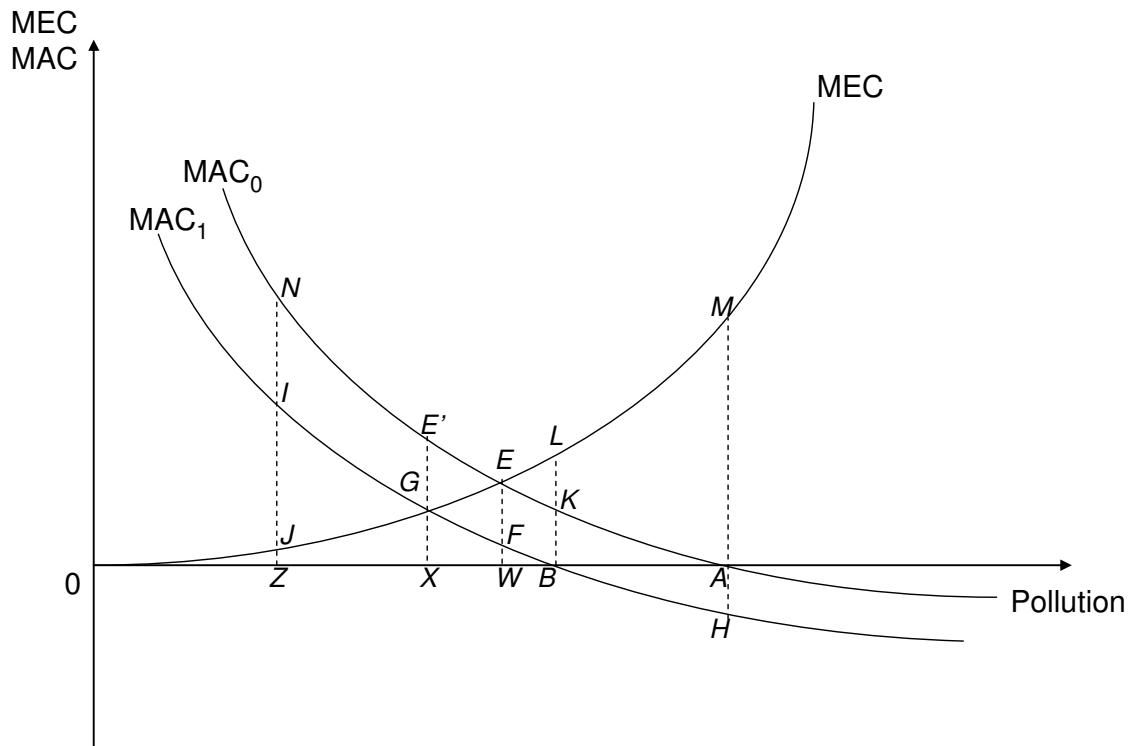
As discussed above, the PH asserts that the private benefits from pollution offsets are sufficient unto themselves to warrant more stringent regulation. The condition that must apply under perfect and complete information/instantaneous MAC shift from MAC_0 to MAC_1 is $\Sigma EI + XGFW \leq HFEA$, where ΣEI is the sum of the private costs (borne by the firm) for the

²⁵ I consider an alternative regulation level at OZ in the next section. Under certainty, the regulator would choose OX as this is the new social optimum.

search, selection and adoption of eco-innovations that stimulate the shift from MAC_0 to MAC_1 . This assumes that the regulator changes regulation from OW to OX , as it would under the assumption of perfect and complete information.

If the PH is modified to allow for the social benefits of reduced pollution as well then the optimality condition changes: $\Sigma EI + XGFW \leq HF EA + XGEW$. This condition simplifies further: $\Sigma EI \leq HF EA + EFG$. Note that the private costs borne by the firm to reduce pollution from OW to OX (i.e. $XGFW$) are more than compensated for by the gain in social welfare arising from the reduction in external costs (i.e. $XGEW$). EFG shows the gap between these two elements, i.e. the social welfare gain arising from shifting from OW to OX . $HF EA$ remains as the benefit (for pollution reduction OA to OW) of the shift from MAC_0 to MAC_1 .

Figure 7 Optimality conditions under shifting MAC curve



The fact that the optimality condition for social optimality is less burdensome than that of the private optimality set out in the PH is of significance. Consider the following condition: $HF EA - XGFW \leq \Sigma EI \leq HF EA + EFG$. This condition implies that the PH *per se* does not apply but given the additional social benefits of more stringent environmental legislation (over and above the private benefits to the polluter) it is economically efficient to meet the cost burden ΣEI . For ease of exposition ΣEI has been characterised in this section as a private cost borne by the firm

but it need not be. For instance the MAC curve shift may arise as a consequence of an increase in green consumerism through the stimulation of eco-labelling, a shift that is a core element of the research overall.

A further point to consider vis-à-vis the analysis of optimality conditions is the outcome if the ÓEI option is not selected. If the polluter decides to meet the regulatory shift from OW to OX by moving along its extant MAC curve (EE') then there is a social welfare loss that occurs as a consequence (GEE'). Under the conditions of certainty as applied in this section the regulator would not choose OX unless the conditions for a shift in MAC applied but real-world decision-making does not take place under such circumstances. Although other costs and benefits appear as areas in Figure 7, ΣEI does not.

The optimality conditions set out above pertain to, first, perfect and complete information and second, an instantaneous shift in the abatement cost curve. The first of these two conditions is relaxed in the next section.

5.4.2 Optimality conditions: asymmetric information

In the case of certainty, both the regulator and the polluter are assumed to be perfectly informed of the location of the MAC and MEC curves *ex ante* and *ex post*. There are various permutations and combinations within this broad assumption that might be relaxed:

- (i) neither agent has perfect and complete information, or one agent does and the other does not;
- (ii) the agent knows with certainty the location of the *ex ante* MAC curve, or otherwise has imperfect information;
- (iii) the agent knows with certainty the location of the *ex post* MAC curves, or otherwise has imperfect information; and
- (iv) the regulator²⁶ knows the location of the MEC curve with certainty, or otherwise approximates.

A standard assumption in neo-classical economic theory (e.g. Pearce and Turner, 1991) is that the firm/polluter is better informed of the location of its MAC curve than the regulator. For ease of exposition, I assume that the firm is not only better informed but *perfectly* informed about the location of *ex ante* and *ex post* MAC curves, whereas the regulator is not. The scenario is thus one of asymmetric information. Further, I assume that the regulator knows the location of

²⁶ Note that whether or not the polluter knows the location of the MEC is irrelevant under the assumption of profit-maximising corporate social responsiveness (as opposed to responsibility). The polluter's decision-making is determined only by its (perceived) MAC curve and the regulations *in situ*.

the MEC curve and sets regulation to maximise welfare in society given this and its assumptions/estimates vis-à-vis the polluter's MAC.

Consider Figure 7 once more. In the previous section, I outlined the social optimality conditions under perfect and complete information: $\Sigma EI \leq HFEA + EFG$. This condition depends on the regulator selecting the optimal pollution level *ex post*, i.e. 0X. Assume that the regulator sets a much more stringent pollution threshold (e.g. 0Z), i.e. it anticipates a more significant shift in the MAC curve than occurs in practice. The 'true' social optimum is 0X and the aggregate social welfare loss for the pollution units 0Z to 0X is *IJG*. If this outcome is generalised and 0Z is taken to be any given chosen regulatory pollution level lower than the *ex post* optimum (0X) then the optimality condition is as follows: $\Sigma EI + IJG \leq HFEA + EFG$.

This condition presupposes that the *ex ante* pollution level was correctly set at 0W; were this not to have been the case then a less restrictive condition might then apply. For instance, assume that the *ex ante* pollution regulation were (incorrectly) set at 0X rather than 0W, i.e. the regulation is already too stringent *ex ante* given that MAC_0 applies. This over-stringency has an associated welfare loss of *GEE'*. Although 0X is the social optimum *ex post*, it is *not* the optimum *ex ante*. Were it not for the imposition of more stringent legislation (0Z) that in turn stimulated the shift from MAC_0 to MAC_1 then this welfare loss would have continued in perpetuity. Once the MAC curve has shifted 0X is optimal and thus the welfare loss *GEE'* no longer applies. Thus the optimality condition under this scenario is as follows: $\Sigma EI + IJG \leq HFEA + EFG + GEE'$.

Some opponents of the PH argue that the capacity for firms to generate pollution offsets is in fact very limited. The extreme case would be the polluter deciding to deal with the more stringent regulation by moving *along* its extant MAC curve as opposed to any shift in the curve being generated. If this scenario were to apply for MAC_0 and pollution regulation 0Z then the subsequent social welfare loss is *JEN*.

The designation of optimality conditions above does not fully account for the assumption of asymmetric information. Under this assumption, the polluter always has an incentive to try to overstate regulatory compliance costs to the regulator. A cursory inspection of Figure 6 shows that, given the assumptions made (MEC upward sloping; MAC downward sloping; MAC curves shift to the left) the gap between the private and social optima decreases after each shift in MAC, i.e. $AW > BX > CY$. Each of these gaps between the respective private and social optima implies a potential private benefit to the polluter from misinforming the regulator. The *potential* private gain were the polluter to be perfectly convincing in this strategic message-sending

would be AWE for MAC_0 , BXE' for MAC_1 and CYE'' for MAC_2 . The associated social welfare losses are given by the area under the MEC curve less the private gain, e.g. AEF for MAC_0 . Were the regulator to be only partly convinced then some pollution level between $0A$ and $0W$ would be selected for MAC_0 , between $0B$ and $0X$ for MAC_1 and between $0C$ and $0Y$ for MAC_2 . Assuming that there is no reason why the regulator would be any more or less 'duped' by the firm for MAC_0 as compared to MAC_1 and MAC_2 , then it is clear that the *expected* welfare loss is lower as MAC curves move leftward and the potential private gain from misinforming the regulator reduces at each iteration.

The extent to which this influences optimality conditions depends on the regulation set. In Figure 7, the private/social optima for MAC_0 and MAC_1 are $0A/0W$ and $0B/0X$ respectively. The polluter would not choose to pollute more than $0A$ and $0B$ for the two respective MAC curves and thus the potential social welfare loss from misinformation is AEM and BGL respectively. If some *proportion* of these losses are realised through misinformation then in absolute terms the welfare losses are bigger for MAC_0 than for MAC_1 . However, this analysis assumes that the pollution threshold is set at some level greater than the social optimum; this does not apply to say $0Z$. Although the potential welfare losses arising from asymmetric information may be significant they are difficult to quantify.

5.4.3 Optimality conditions: asymmetric information and a gradual shift in abatement costs

Even if the MAC curve does shift, it is likely that stricter legislation (as proposed by the PH) would not result in an instantaneous shift but a *gradual* shift over time. In the short term, it is likely that the MAC curve is fixed and thus the polluter, in order to achieve regulatory compliance, is forced to incur the costs arising from a movement *along* the extant MAC curve. In Figure 7, for the regulation levels $0X$ and $0Z$ the social welfare losses in the short term are GEE' and JEN respectively. I have set out the optimality conditions for these two regulatory pollution thresholds ($0X$ and $0Z$) above for an instantaneous shift from MAC_0 to MAC_1 . The instantaneous shift is the best case scenario: $\Sigma EI \leq HF EA + EFG$ applies for $0X$ and $\Sigma EI + IJG \leq HF EA + EFG$ applies for $0Z$ and an instantaneous shift. The welfare losses incurred in the short term (GEE' and JEN for $0X$ and $0Z$ respectively) must be added to the Left Hand Side of the optimality conditions. The optimality conditions in this case depend on the duration of the 'short term' and the discount rate applied to the analysis. A longer duration and a higher discount rate both lower the likelihood that more stringent regulation (either $0X$ or $0Z$) is economically efficient.

The optimality conditions set out above have not, to my knowledge, been expounded before in the literature. Section 5.2 provides a synopsis and commentary on studies that have attempted to validate or refute the PH using both theoretical models and empirical data. These models do not however consider the social welfare implications of stimulating pollution offsets. In some respects this is entirely reasonable as it is consistent with the focus in the PH on *private* costs/benefits. However, I would contend that, as a consequence of this focus, the PH literature does not tell the full story. I would add that it is difficult to add the social welfare dimension in empirical testing in that there is considerable uncertainty vis-à-vis the location of the MEC curve. Further, the potential welfare losses arising from asymmetric information are methodologically challenging to estimate as to do so would require an analysis of strategic misinformation; if the regulator is 'duped' then in all likelihood the researcher would be as well.

5.5 Chapter summary and conclusions

The PH provides an important context to the overall research in that it is concerned with whether more stringent environmental legislation is appropriate. The PH contends that this 'operationalising' of industrial sustainability should not rely on corporate social responsibility *per se* but on the private gains (in terms of profitability) that the firm might realise if a search for eco-innovations is stimulated by more stringent regulation. The core argument is that such a search for eco-innovations occurs if and only if the 'stick' of mandatory regulation is applied. The reasoning given is that firms do not otherwise search for 'win win' outcomes and thus that the low hanging fruit of pollution offsets remains unpicked. Porter claims an additional benefit in terms of the potential to export these environmental technologies to other countries that will later play catch-up.

The empirical evidence on the validity or otherwise of the PH is equivocal. Much of the literature supporting the PH is based on anecdotal case studies and it is difficult to generalise and determine the extent to which such outcomes are typical. There is also a systemic bias: firms that might have attempted to search for 'win win' outcomes but ended up negatively affecting their profitability are unlikely to trumpet this outcome; and researchers might wish to report and promote positivism in industrial sustainability through the laudable desire to instigate eco-reform and/or for personal gain through consultancy. Econometric analyses fail to provide a definitive answer vis-à-vis validity (Roediger-Schulga, 2001).

This chapter has provided two key developments to the PH literature. First, the fundamental proposition of Porter is that the polluter is forced to search for eco-innovations and this is the stimulus for the generation of pollution offsets. Once the polluter's MAC curve is conceptualised as potentially *shifting* then the non-economic argument of Porter can be

transposed into welfare analysis vis-à-vis the economics of pollution regulation. In my analysis, this shift pre-supposes three conditions: (i) the marginal abatement cost curve captures marginal abatement costs *net of the private benefits of abatement*; (ii) the MAC is based on the *extant information set* of the polluter vis-à-vis opportunities for abatement; and (iii) the MAC is based on *extant market and institutional conditions*. Condition (i) allows for the MAC curve to be negative. This is irrelevant if the polluter is perched on the edge of its efficiency frontier but is of consequence if it is not. Further, I argue that changes in the information set and/or market conditions might cause this segment of the MAC curve to be highly relevant. For instance, any positive momentum in eco-labelling would imply a shift in the demand for green products and thus an inward shift in MAC; it is now more costly to pollute as in so doing the likelihood of winning the green consumer market share is diminished commensurately.

The optimality conditions set out in this chapter under various conditions constitute the first significant contribution to the PH literature. They arise from the shifting MAC curves and the thus from the three conditions outlined above. What these conditions demonstrate is noteworthy. First, even under conditions of certainty, Porter's contention that offsets will exceed abatement costs is a sufficient but not necessary condition for assessing whether regulatory intervention is economically efficient. The decrease in the social costs associated with environmental pollution should be factored in. Second, there is a temporal dimension to the analysis that has hitherto been under-explored. Even if a shift in the MAC curve does occur *ex post*, there is a need to appraise expected welfare losses in the interim period between the inception of regulation and the shift occurring. In this period even under the best case scenario (wherein the regulator precisely locates the *ex post* MAC curve) there are welfare losses as the regulation imposes a burden ($MAC > MEC$) until the shift is completed.

As well as generating the optimality conditions under different conditions, the second contribution that this chapter has made to the PH is the analysis of choice under uncertainty and asymmetric information. Under these conditions there is an omnipresent incentive for the profit-maximising polluter to attempt to dupe the regulator into believing that its MAC is steeper than the polluter knows it to be. With the presumption of MAC curves shifting inwards there is a concomitant convergence between the private and social optima and diminution of the potential welfare losses associated with this strategic game being played between the polluter and the regulator. This should be a further contributing factor on the credit side of the evaluation of the economic efficiency of environmental regulation.

The rest of this research in many respects develops some of the themes elucidated in this chapter. The next chapter explores theoretical constructs within the economics of eco-

innovation and the chapter that follows tests these theories empirically. What these two chapters are fundamentally concerned with is how polluters make decisions with regards pollution control, i.e. the location and shape of the MAC curve. What I draw out is the literature that suggests that firms are not perched on the edge of their efficiency frontiers vis-à-vis pollution control regulation and thus that the shifts in MAC curves (arising from changes in the polluter's information set) described in this chapter have both a theoretical and empirical basis. Chapter 8 then focuses on one tool (eco-labelling) that might stimulate the kind of change in market/institutional conditions that might also cause a MAC shift, and the reasons why government intervention might again be merited in efficiency terms owing to the existence of game theoretical interactions, in this case between the firm and the consumer.

6 THE ECONOMICS OF ECO-INNOVATION

6.1 Introduction

There has been considerable research effort directed at refining the *measurement* of corporate environmental and sustainability performance, e.g. the documentation of firms' environmental management systems, environmental reporting protocols, environmental accounting *etc.* Chapter 4 outlined some of these relative and absolute measures of corporate sustainability. However, there has been comparatively little research to date on the environmental change *process* in the greening literature (Angell, 1998), i.e. the stimuli for shifting between stages of corporate eco-performance. This chapter attempts to redress this important gap in the literature; it is modified version of Hussain (2003). It provides propositions concerning this change process that are then tested empirically in Chapter 7.

In this chapter, I modify general economic theories in innovation to incorporate *eco-innovations*. 'Eco-innovation' might be defined as any change in a production process, instigated by the firm, which reduces the impact of that production process on the natural environment or on society. The 'production process' is a multi-stage operation from raw material extraction through to final waste disposal, i.e. 'cradle to grave' (SETAC, 1993). Thus, eco-innovation under this definition is not restricted to that part of the production process that occurs at the production site. 'Supplier challenges', i.e. sourcing the purchase of inputs to the firm's production process from suppliers that meet the firm's sustainability/environmental criteria, is therefore a form of eco-innovation under the definition applied. This example also illustrates the distinction between eco-innovation and eco-invention: eco-innovation does not need to be technology-driven. This distinction is elucidated in the seminal work of Schumpeter (1934):

Innovation is possible without anything we should identify as invention, and invention does not necessarily induce innovation but produces itself...no economically relevant effect at all. (Schumpeter, 1934, Vol.I: 84)

As an investigation into eco-innovation as defined above, this chapter constitutes an enquiry both at the micro-level 'black box' of the firm and at the macro-level of industry interactions. The analysis in this chapter is a necessary component of the overall research as the effectiveness of any policy prescriptions depends on the mechanisms by which the firm responds to them. A society's ability to chart and to follow a sustainable development path depends on its ability to stimulate technical change in economic processes. This implies the adaptation of organisational and institutional structures as well as its patterns of consumption

and throughput. The outcome of this adaptation should be to move the ‘innovation trajectory’ of firms towards sustainability. This is the essence of the investigation of this chapter.

This chapter has the following structure. Section 6.2 reviews the literature on NC economic theories of innovation: demand-pull/supply-push; factor endowment; and growth theoretical models of induced innovation. My research focuses on evolutionary theories of innovation as I argue that, given the nature of eco-change, the models derived from and by Nelson and Winter (1982) appear to be the most relevant to the greening of industry. Evolutionary theories are discussed in Section 6.3. Whereas Sections 6.2 and 6.3 are analyses of micro firm-level behaviour, Section 6.4 turns to consider macro industry-level influences. Section 6.4 presents the path dependent school (Arthur, 1989) that asserts that systems can be ‘locked-into’ technologies that are sub-optimal. Section 6.5 provides a synopsis of the implications of the various models of innovation for sustainable development. Two sections concerning ‘operationalising’ sustainability then follow. Section 6.6 considers institutional change and Section 6.7 the intra-firm ‘black box’. Section 6.8 concludes, linking the innovation theories with the application of environmental management tools.

6.2 Neo-classical theories in innovation

There are four critical categories of factors within conventional NC innovation theory: the level of demand; advances in the state of knowledge; relative prices of factor inputs to production; relative endowments of these factors (Ruttan, 1996). There are three major traditions in NC innovations theory: ‘demand-pull’; ‘factor endowment’; and ‘growth theoretical’ (*ibid*). Each purports that one or more of these four factors is/are of the greatest significance. In general, these NC theories rely upon the conventional profit-maximisation assumption for firms, wherein at each decision-iteration the firm selects the innovation alternative that maximises profit given its current state of knowledge and its expectations concerning market conditions in the future. It is assumed then that each and every firm would make the same innovation selection given identical knowledge/expectations. A firm’s specific history of innovation-implementations is irrelevant under such an assumption. This perspective is thus fundamentally different from the routine-based innovation ‘searches’ of evolutionary economics discussed in Section 6.3.²⁷

The demand-pull school was first developed by Schookler (1962) and Lucas (1967). It purports that innovation is primarily responsive to changes in aggregate demand patterns as opposed to the supply-side force of advances in knowledge. In the environmental domain, this theory

²⁷ The micro-economic neo-classical model of David (1975) includes a probabilistic learning process that is dependent on the firm’s initial state, and thus is similar to Nelson and Winter (1982) evolutionary model.

would imply that the fundamental driver of eco-innovation is green consumerism, discussed in detail in Chapter 8. I would support the contention of Mowery and Rosenberg (1979) that the theoretical validity of the ‘demand-pull/supply-push’ schools is questionable in that virtually all factors that might determine innovation rates and shifts can be defined under either the ‘demand-side’ or ‘supply-side’ categories. The corollary of this proposition is that the relative significance of the two market forces - the supply-side investment in R&D and demand-side taste changes - remains unresolved. Both are important, but neither in isolation can fully explain innovation.

The factor endowment/relative prices of factor inputs argument stems from Hicks (1932): if one factor input becomes expensive relative to another then investment (and consequent innovation) is targeted on methods/technologies that economise on the use of that input. In the NC world-view of long-run competitive equilibria, each factor input is paid its marginal revenue product and this basic tenet alone is sufficient to explain the factor price argument (Salter, 1960). This world-view of efficiency pricing of factor inputs is challenged under the evolutionary models. The Hicksian model is not radically different from the supply-push analysis: if the endowment of a given factor rises then its price falls, *ceteris paribus*; if the price falls then the demand by firms for that factor input rises *ceteris paribus*. Again, I would support the contention that the relative price of factor inputs is *a* determinant in the innovation trajectory, but not *the* sole determinant.

Ahmad (1966) is perhaps the most significant micro-economic model of innovation to be developed from the growth theoretical school (Ruttan, 1996). He employs the concept of a historic ‘innovation possibility curve’ (IPC). The IPC is a set of feasible innovations that can be developed with the injection of some set R&D expenditure. The feasible set of innovation outcomes is determined by the current state of knowledge: it comprises a latent set of potential processes/technologies that could be designed and implemented with current knowledge. The optimal selection *ex ante* then depends on the relative prices of factor inputs. The Ahmad model differs from others in the NC paradigm in that, once a given option has been selected, the *ex post* IPC then shifts as there is then a new set of feasible alternatives corresponding with the *ex post* information set. In this way, a firm’s history of innovations matters.

The Ahmad (1966) micro-economic model might be reapplied to the environmental domain. Further, although the application here is based on a fundamentally NC behavioural model, with the assumption of efficient selection between competing alternatives by the firm, the analysis presented below endogenises the natural resource input to production. The raw material factor

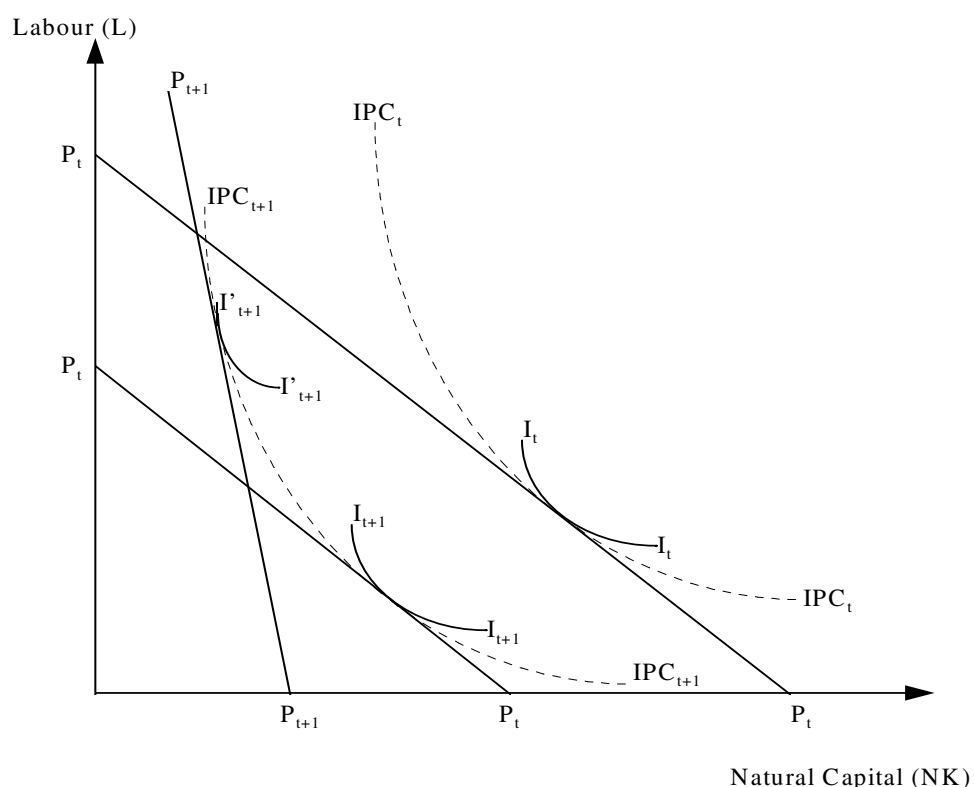
input ('natural capital') is excluded by Ahmad (1966), as is the case in the majority of NC models (Daly and Cobb, 1989).

Consider Figure 8. The two axes show the two assumed constraints on production to be natural capital (NK) and labour (L), whereas the Ahmad (1966) model endogenises labour and manmade capital (MK). In my re-interpretation of Ahmad (1966), MK (i.e. plant and machinery) is exogenised. Following Ahmad (1966), Figure 8 depicts a one-stage static model. The firm has a fixed exogenously-determined budget to be allocated only between the two competing factor inputs. Assume that I_t is the unit isoquant describing the *ex ante* position. This isoquant is the outcome of previous iterations of the innovation adoption-selection process. At time t there is assumed to be some exogenously-determined R&D spending injection. There is a single *ex post* IPC (given by IPC_{t+1}) that arises, given (i) the *ex ante* optimising isoquant (I_t) and (ii) the R&D spend. If the price ratio remains constant, then the cost-efficient isoquant to shift to is given by I_{t+1} . However, if relative prices were to change to $P_{t+1}P_{t+1}$, i.e. L becomes cheaper relative to NK, then it is no longer optimal to select I_{t+1} ; the optimal innovation to develop at this iteration is then I'_{t+1} , i.e. one that 'economises' on the use of the factor input (NK) that has become relatively expensive.

In Figure 8 the shift in the optimal innovation from I_t to I'_{t+1} leads to an outcome which *ex post* has a higher labour input level to production along with a lower use of natural resources. This outcome both reduces environmental loading/throughput and increases employment (under the assumption that there is under-utilised employment capacity). This substitution of natural resources for labour might take the form of the employment of a dedicated in-house environmental management team which 'operationalises' efficiency gains from resource accounting or through, say, an analysis of CGS (Atkinson, 2000). A second example might be the recruitment of industrial ecology analysts.

My re-application of Ahmad (1966) in Figure 8 endogenises L and exogenises MK. If Figure 8 is modified to have MK rather than L on the vertical axis then a parallel argument applies; if the relative price of natural resources increases then there is a tendency for the optimising isoquant (and the associated direction of innovation) to shift from I_t to I'_{t+1} . The substitution is again away from NK but this time toward MK. This might occur if the application of a production technology that reduces waste generation, implying reduced natural resource consumption per unit output.

Figure 8 An induced innovation model [adapted from Ahmad (1966)]



The standard economic assumption is that MK is fixed in the short term. Modifications to the capital stock might be sub-optimal given the sunk investment costs. Thus, the period between successive iterative steps in capital-replacement can be long. This can imply a time lag between changes in the relative price of different innovation options occurring and firms' responses to these changing conditions. In the model presented above, the firm maximises profit at each respective iteration given the relative prices of the factor inputs *at that iteration*. This assumption might be relaxed so as to permit an expectations-augmented firm response to the selection procedure, which is absent from Ahmad (1966) and the associated literature.

Assume that the firm anticipates that the sustainability agenda will stimulate a shift in relative factor prices some time in the future. If this shift is predicted to occur during the lifespan of the current technological innovation, i.e. before the next iteration, then profit-maximising behaviour can imply modifying the current selection to take expected relative price changes into account. In Figure 8, if it is assumed that relative prices stay constant then the optimising isoquant is I_{t+1} . Assume that I_{t+1} is an end-of-pipe technological eco-innovation that has an expected life span of 20 years. Further, assume that I'_{t+1} is an industrial ecology innovation that reduces throughput. If the firm predicts that society (through regulation and/or green consumerism) is likely to provide financial incentives for throughput-reducing measures and/or

penalise end-of-pipe solutions during the course of the 20 year iteration then I'_{t+1} may be a profit-maximising selection.

The Ahmad model and its associated environmental application rely on the twin standard NC assumptions that the firm maximises profits and is efficient in its allocation of expenditure on the development and implementation of innovations. It is a comparative static analysis; there is a unique equilibrium defined by one single criterion (efficiency). The evolutionary school challenges this perspective.

6.3 Evolutionary theories in innovation

Since the 19th century, economists have borrowed and adapted concepts from evolutionary biology (Rammel and van den Bergh, 2003). However, the economic analysis of evolution and adaptation of evolutionary principles to economics has been the adaptation of the concept of 'survival of the fittest', whereas van den Bergh (2003) argues that the concept that better fits the economic system is survival of the *fitter* or *sufficiently fit*.

An evolutionary investigation into innovation (and sustainability in innovation) sees innovation as evolutionary in the sense that the choice between innovation options is complex, multi-dimensional and dependent on the extant (and historical) social and cultural milieu. Under NC growth theory, there is one (and only one) optimal relationship or equilibrium between technology and growth; under evolutionary thinking, there is some scope for inefficient firm behaviour so long as firms are 'sufficiently fit'.

'Evolution' has become a fashionable word in economic theory of late owing to the revival of Schumpeterian analysis that Ruttan (1996) attributes to Richard Nelson and Sidney Winter (Nelson and Winter, 1973; 1974; 1975; 1977; 1982; Nelson *et al.*, 1976). However, the link between evolutionary biology and economics is much older. Marshall is recognised as a highly significant contributor to NC thinking; he comments on the limitations of NC comparative statics:

[t]he Mecca of economics lies in economic biology rather than economic mechanics. But biological conceptions are more complex than those in mechanics; a volume on foundations must therefore give a relatively large place to mechanical analogies; and frequent use is made of the term equilibrium, which suggests something of a statical analogy. This fact, combined with the predominant attention paid in the present volume to the normal conditions of life in the modern age, has suggested the notion that its central idea is "statical" rather than "dynamical." In fact it is concerned throughout with the forces that cause movement; and its key note is that of dynamics rather than statics. (Marshall, 1948: xiv, quoted in Nelson and Winter, 1982: 44)

What the various contributions to evolutionary economics have in common is the emphasis placed on the *process of change* (dynamic analyses), combined with a critique of NC economics. The fundamental criticism is the modelling of NC economic theory after Newtonian mechanics, a modelling that was borne out of the ambivalence between having a theory that captures the key structural aspects of the economic system and processes on one hand, and an abstract theory that was analytically tractable and logically complete on the other (Nelson and Winter, 1982). This analytical tractability and the associated ‘mathematicalisation’ of economic analysis can lead to what has been termed the “fallacy of misplaced concreteness” (Georgescu-Roegen, 1971:320). This is poignantly expressed by the mathematical economist and Nobel Laureate Wassily Leontieff:

Econometricians fit algebraic functions of all possible shapes to essentially the same sets of data without being able to advance, in any perceptible way, a systematic understanding of the structure and operations of a real economic system (Leontieff, 1982:105)

Although ‘mathematicalisation’ is not rejected, evolutionary economics attempts to characterise and thus to predict better the workings of a ‘real’ economic system, *viz.* Marshall’s “normal conditions of life in the modern age”. Evolutionary economics thus focuses not on comparative statics but rather on the forces that generate/hinder innovation and structural change, *i.e.* the *dynamics* of changing from one equilibrium to another. This section first documents the pioneering work of Nelson and Winter (Section 6.3.1) and then considers the different views on the rate of economic change in the evolutionary economics school (Section 6.3.2).

6.3.1 The Nelson-Winter evolutionary models

The Nelson-Winter models reject some of the ‘excess baggage’ of NC micro-economic modelling, including: “the global objective function, the well defined choice set, and the maximising choice rationalization of firms’ actions” (Nelson and Winter, 1982:14). The dynamics of firm innovations is conceptualised under the Nelson-Winter models as, at any given point in time, “governed by its current decision rules, which link its actions to various environmental stimuli” (Nelson *et al*, 1976:91). Whilst in orthodox NC theory the decision rules are assumed to be the consequence of maximisation, in evolutionary theory they are treated as simply reflecting the historically determined ‘routines’ that govern the actions of a firm. By ‘routines’ Nelson and Winter refer to: “all regular and predictable behavioural patterns of firms” (Nelson and Winter, 1982: 15). The ‘search’ for better production techniques and the ‘selection’ of firms by the market are then the two fundamental mechanisms of the Nelson-Winter models. Nelson and Winter (1982) do recognise that there is corporate behaviour that is by nature “nonroutine” (1982:14). They acknowledge that innovation-selection and outcome-

prediction are imperfect; however, they contend that their models provide a better predictive framework than the standard NC analysis.

Although the Nelson-Winter models do critique and amend certain NC behavioural assumptions, others are maintained. The locus of economic choice is the margin (as opposed to the mean or aggregate) but the principle of efficient equi-marginal principle of maximisation across alternatives is rejected. The motivation of firms is still assumed to be profitability and that of individuals to be utility-gains but the NC assumption of maximisation is rejected in favour of 'satisficing' behaviour which borrows from Herbert Simon (1955; 1959). The Nelson and Winter (1975) proposition is that firms engage in searches for technical innovations when profits have fallen below some critical threshold²⁸. The end-point of this stochastic search process is the implementation of an innovation that is *sufficiently* profitable so as to exceed the threshold profitability condition. This is an iterative procedure: there is a search for a profit-increasing innovation option; there is an evaluation as to whether that option raises profits sufficiently; if it does, the procedure ends and if not another option is searched for and the same procedure applied. This is 'satisficing' as opposed to maximising behaviour. The inducement to innovate comes about through the competitive process and the twin objectives of survival and growth as opposed to efforts to profit maximise.

What is implied by the NC assumption of maximising rational behaviour by firms is that any shift from one optimising equilibrium to another is automatic and stimulated by an exogenous shock to the system, for instance a profit-increasing innovation becoming available or a shift in the demand curve. By contrast, the search process of the Nelson-Winter models is (predominantly) set in motion by the aforementioned profitability threshold condition; if an exogenous shock does not decrease profitability sufficiently then the firm is assumed then not to respond. Even if this threshold is transgressed, then under Nelson-Winter the firm does not optimise *per se* in that searches are 'localised', as described in Nelson and Winter (1975) and depicted in Figure 9²⁹.

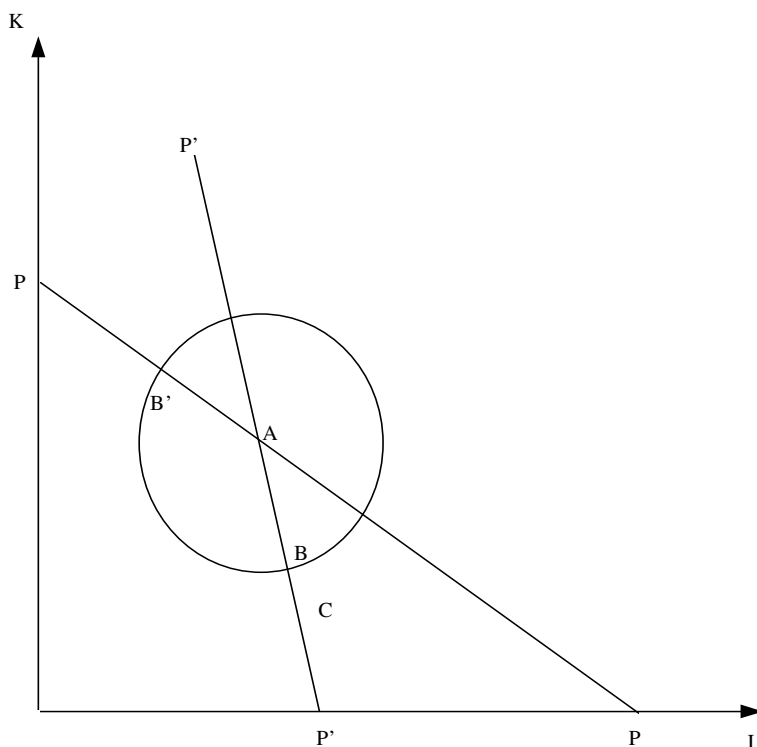
The Nelson-Winter search for innovation is generated by one of three sources: internal R&D; transferred from suppliers; and imitation of the practices of competing firms. In each case, the Nelson-Winter models assume that the production *status quo* and the firm's history of innovation-applications determine the search procedure. In Figure 9, different points in K/L space represent different production techniques, *viz.* different combinations of manmade capital

²⁸ This condition is relaxed in Nelson and Winter (1982) which explicitly introduces "directed research": there is then assumed to be some on-going innovation sampling as well as searches induced by the threshold profitability condition.

²⁹ Nelson and Winter use the abbreviation 'K' for manmade capital, otherwise referred to here as MK.

(MK) and labour (L) inputs. Assume that point A is the initial input combination, i.e. the *ex ante* position. As Figure 9 borrows from Nelson and Wilson (1975) there is no unit isoquant depicted. Point A thus represents a given combination of MK and L inputs that in turn corresponds with some output level. Assume that combination A no longer generates *sufficient* profits; this stimulates an innovation search. Nelson-Winter state that there is a greater probability of finding a solution (and terminating the search procedure) at point B rather than at C. The analysis differs from neo-classicism in that this assertion does not depend on the firm's expectations concerning absolute profitability levels at B versus C; the firm simply is more likely to 'try' option B first before C, as the latter implies a larger shift from its current production process techniques. Note that the search process is one of "trial-and-error character" (Nelson *et al.*, 1976: 91, emphasis in original).

Figure 9 'Sampling' and 'search' mechanisms [following Nelson and Winter (1975)]



I would propose that the Nelson-Winter analysis might be considered an adaptation of NC transactions cost theory coupled with expectations-augmented risk-management strategies, but with the caveat that the NC assumption of profit-maximisation is rejected. If the standard assumption of risk-aversion applies, then the firm's preference for option B over C can be explained by the increased risks (and higher transactions costs in risk-appraisal) associated with

choosing an innovation option that lies in uncharted corporate territories. However, Nelson-Winter differ from neo-classicism in that, even if the expected payoffs from C are sufficiently higher than B so as to override risk-aversion and transactions costs in a conventional analysis, the ‘satisficing’ manager still selects B so long as profits are sufficiently high at B.

Although the search process is stochastic, the innovation outcome that is accepted is dependent on the relative prices of the factor inputs. In Figure 9, B and B’ are equi-distant from the initial position A. However, in order for a new innovation (and thus a new position in K/L space) to be accepted, it must represent a sufficiently high profit increment over the *ex ante* production process. In Figure 9, PP and P’P’ are relative price lines for factor inputs with the former representing relatively cheap L and the latter relatively cheap MK. Note that neither PP nor P’P’ are production possibility frontiers. Moving from A to B implies increasing the L input and decreasing MK; if the firm ‘searches’ for and evaluates this option then it is more likely to be accepted (and the search ended) if PP applies rather than P’P’ as, under relative prices PP, labour is relatively cheap. Similarly, B’ is more likely to be adopted if P’P’ applies.

A re-application of Ahmad (1966) induced growth model to environmentalism was set out above. The same principle can be applied here to the Nelson-Winter EE models. If K on the vertical axis of Figure 9 is replaced with natural capital (NK) then the model depicts a firm’s search for innovations that substitute labour for natural resource inputs and vice versa. Again, modifying relative prices so as to make natural resource inputs more expensive should imply a larger probability of natural resource-saving innovations being accepted, in this case with ‘satisficing’ as opposed to profit maximising behaviour.

6.3.2 Rates of change in the evolutionary economics school

The Nelson-Winter model described in Section 6.3.1 characterises the innovation process as an incremental process, the analogue to Darwinian natural selection: “very short and slow steps” (Darwin, quoted in Gowdy, 1994:114). Winter (1984) clarifies the varying time-frames which characterise the dynamics of the Nelson-Winter models:

Some economic processes are conceived as working very fast, driving some of the model variables to (temporary) equilibrium values within a single period (or in a continuous time model, instantaneously)...[S]lower working processes of investment and of technology and organisational change operate to modify the data of the short-run equilibrium system from period to period (or from instant to instant). The directions taken by these slower processes of change are directly influenced by the values taken by the subset of variables that are equilibrated in the individual period or instant. (Winter, 1984:290)

There is thus in the Nelson-Winter models a two-way interaction between short-run factors (such as demand/supply interactions and associated equilibrium market price fluctuations) and

long-run factors such as innovation searches. This two-way interaction is described as “reverse Schumpeterian” by Nelson and Winter (1977): “[linkages] through which market structure is itself affected by the conditions of technical progressiveness in an industry” (Nelson and Winter, 1977:273). Firms both react *and* impact on their business environment: “firm behaviour patterns and market outcomes are jointly determined over time” (Nelson and Winter, 1982:18). Although the parallel is not drawn in the literature, I would contend that the co-evolution described by Nelson and Winter is similar to the Arthurian network externality theory (Arthur, 1989; 1990; 1994) which is discussed in the next section.

This ‘co-evolution’ between firms in an industry has been extended in theories of social learning (Boulding, 1970; de la Mothe and Paquet, 1996). Innovation is then a socially embedded process that cannot be understood without taking into consideration its institutional and cultural context (Lundvall, 1992). With ‘learning’ at the centre of innovation, the innovation process and the institutional set-up of the economy mutually shape each other. Thus ‘stakeholder dialogue’ might be added to Nelson-Winter list of sources of innovation (R&D; suppliers; competitors). This is arguably particularly pertinent for eco-innovations in particular as compared with innovations in general.

The Nelson-Winter models have been characterised as punctuated equilibria with each search process leading to a new equilibrium through *iterative* steps (Gowdy, 1994). Although the Nelson-Winter models have been described as neo-Schumpeterian by Ruttan (1996), I would propose that their iterative nature makes them distinct from the Schumpeterian mode of change:

[E]conomic life changes; it changes partly because of changes in the data, to which it tends to adapt itself. But this is not the only kind of economic change; there is another which is not accounted for by influence on the data from without, but which arises from within the system...*which so displaces its equilibrium point that the new one cannot be reached from the old one by infinitesimal steps.* (Schumpeter, 1934: 64, emphasis in original)

I would characterise a transformative (i.e. non-iterative) change under the Nelson-Winter models as a ‘search for a new search mechanism’. The Nelson-Winter description of the modes of operation of the firm does not lend themselves to such transformative changes. Allen’s (1994) evolutionary model of innovation is similar to the Schumpeterian analysis in that he distinguishes between changes brought about by ‘typical’ behaviour of ‘average’ system components and more structural, qualitative, changes brought about by ‘non-average’ components that still originate from *within* the system. Gowdy’s (1994) model of “punctuated equilibria” also characterises some shifts as non-incremental, but in contrast to Schumpeter

(1934) focuses on changes from *outside* the system as opposed to from within it³⁰. Gowdy (1994) describes selection as a process that occurs at three levels: the ‘firm level’ with the standard model of natural selection at the margin; the ‘inter-firm level’ where innovation can occur from outside the firm’s own decision-making parameters; the ‘industry level’ where sudden macro-shocks “fundamentally alter the rules of the game” (Gowdy, 1994: 125). The latter might be extended to include socio-cultural changes and shocks to the system, although such shocks are missing from the author’s analysis.

In a broader, more socio-politico-cultural interpretation, society, economy and polity are all included in this co-evolution (Boulding, 1970; Norgaard, 1994). Lundvall (1992) presents a theory of national systems of innovation based on the idea that learning is a “socially embedded process which cannot be understood without taking into consideration its institutional and cultural context” (Lundvall, 1992: 1). ‘Networks’ are another way to look at socio-economic linkages. The firm has been described as “a creative experimental organization embedded in a wider network of knowledge-generating relationships” (Metcalf and Diliso, 1996: 58). The theory of inter-organisational learning tries to explore particularly the *inter-firm* network of knowledge-generating relationships and the learning processes taking place therein. It tries to identify the conditions for information exchange between firms (Andersen, 1998). The findings of Andersen (1998) suggest that even if it is true that the economic process stimulates institutional changes, there might still be barriers to inter-organisational learning in the form of high external dynamic governance costs and long payback periods.

The evolutionary economics model of Gowdy (1994) is similar to that of Lundberg (1989) from the organisational theory literature, although there appears to be little cross-fertilisation of theories between the disciplines. Lundberg characterises three different types of change: incremental, strategic and transformative. The difference lies in the extent to which the behavioural changes require fundamental modification to underlying values, assumptions, and cognitive frameworks (Angell, 1998). Angell (1998) also points out that it is not clear which of these types of changes best explains corporate environmental change activities, since environmental management studies tend to focus on extensive, i.e. transformative changes, whereas the implementation of many corporate environmental and sustainability activities has been characterised as incremental in nature. This discussion becomes an important part of policy-making if the ultimate social goal is the transformative change towards a sustainable society. There then might be a conflict between the promotion of iterative eco-improvements

³⁰ The distinction between changes originating from ‘outside’/‘inside’ the system can be a trivial matter of semantics in the definition of the system boundary. What is more critical is the fact that such changes are endogenised in evolutionary economics modelling whereas neo-classicism exogenises them.

and more transformative change, an issue that is given curt attention in the organisational theory literature. I return to this issue in Section 6.5 after first setting out and developing models of path dependency which should contribute to any discussion of innovation theories and sustainable development.

6.4 Path dependent models of innovation

The Nelson-Winter models, in common with other evolutionary economics models, are path-dependent in the sense that ‘history matters’: “through the joint action of search and selection...with the condition of the industry in each period bearing the seeds of its condition in the following period” (Nelson and Winter, 1982:19). However, I would concur with Ruttan (1996) that the path-dependent school of Bryan Arthur (1989; 1990; 1994) and Paul David (1985; 1986; 1993) are distinct from the evolutionary economics school and Nelson-Winter tradition.

Although Arthur (1989) characterises the innovation process at the firm/micro-level as iterative, the industry/macro level system equilibrium can be shifted in a fundamental (transformative) way. Arthur (1989) demonstrates that network externalities can arise. Industries can then be ‘locked into’ a path which is sub-optimal owing to the positive feedbacks which arise at early iterations in the innovation path:

Often there is a multiplicity of patterns that are candidates for long term self-reinforcement; the accumulation of small events early on ‘pushes’ the dynamics of technical choice into the orbit of one of these and thus ‘selects’ the structure that the system eventually locks into. (Arthur *et al.* 1987:294)

A critical condition for such a lock-in to occur under the Arthur models is increasing returns to scale associated with the innovation structure which the industry becomes locked into. If increasing returns are exhausted and the innovation path faces constant/decreasing returns then technologies might be developed now even though they were previously rejected, thereby breaking the lock-in.

David (1985) describes the historical process of lock-in for the ‘QWERTY’ structure of a typewriter keyboard. This technology is inefficient and arose out of mechanical requirements. Increasing returns to scale refers to the reduction in user cost of the QWERTY as it achieved universal acceptance. David (1985) presents two related arguments: first, the technology is quasi-irreversible in that the deadweight costs associated with retraining typists to use an alternative keyboard format are too large to merit a technology-shift; there is a related issue of

‘technical inter-relatedness’ in that the system has to be compatible with other extant technological applications.

Although the Arthur model shares with the Nelson-Winter model the concept of shifting production functions (as opposed to movements *along* a fixed, exogenously-determined production function), Arthur assumes that the firm has perfect and complete information concerning the available (and potentially available) technologies and chooses rationally between them, i.e. profit-maximises. Thus, the stochastic element to the search process and the ‘satisficing’ behavioural assumptions of Nelson-Winter models are rejected. Section 6.5 explores the implications of integrating the Nelson-Winter search procedures with the Arthur lock-in in the context of the corporate sustainability debate.

6.5 Innovation theories and sustainable development

This section evaluates the different competing theories of innovation and considers the lessons that can be learned from these theoretical perspectives for corporate sustainability, i.e. converting environmental and social aspects of the firm’s production into a ‘core’ as opposed to a ‘peripheral’ concern (Ledgerwood *et al*, 1993). Although some of the green policy ramifications of the various competing models have already been drawn out above, this section provides extensions and summary assessments of the theories presented vis-à-vis sustainability.

The models presented from within the NC paradigm differ with respect to the location of and determination of the IPC. This argument is significant in that the IPC is the locus of potential innovations that firms can choose between given the current information set. I would criticise the necessary assumption under the demand-pull school that the shape and location of the innovation possibility curve is independent of any historical bias in the path of technical change³¹. This implies that, for some given level of spending in innovation and R&D, the firm faces the same opportunities *ex ante* as *ex post*: I consider this unrealistic. The demand-pull analysis implies that *all* innovations are explained as movements *along* the innovation possibility curve, as opposed to the *shifts* in the curve that occur in the NC Ahmad (1966) micro-economic model. Although Ahmad (1966) appears the more empirically plausible NC model, it is driven by exogenous changes in the business environment *in which the firm finds itself*. The ‘black box’ of learning, networks, search mechanisms and R&D is exogenised. There is no element of proactive firm behaviour, no co-evolutionary interaction between the firm, its competitors, industry and society. Again, I find this implausible, especially for eco-innovations wherein firms/industry bodies are actively engaged by regulators in the formulation

³¹ The same criticism applies to the growth theoretical theories of Kennedy (1964) and Samuelson (1965) that are not discussed here; these models consider factor *endowments* as opposed to factor prices, but are fundamentally similar in essence to the demand-pull school.

of policy, and where there is a good deal of documentation of proactive ‘pollution prevention pays’ schemes.

What then can be garnered from the NC models for ‘operationalising’ sustainability? ‘Demand-pull’ is certainly a significant factor in determining innovation outcomes (although it does not explain *all* innovations as demand-pull proponents would claim). Demand in these models refers to the demand by firms for factor inputs as opposed to the final consumer demand for their output. This factor-input demand is a *derived* demand. If green consumerism applies then the final demand is dependent on this derived demand, for instance if green consumers only select products which have a low (perceived) natural resource use content, e.g. minimised packaging. In this case, the relative price of natural resource use in general increases, therein implying a shift in the optimising production isoquant. A similar shift might be instigated through higher state taxation of natural resource use, and/or lower taxation of other factor inputs; this does depend however on the cross elasticity of substitution between factor inputs. This cross elasticity might be influenced in turn through incentives to promote full cost accounting and ‘genuine savings’ assessments (Atkinson, 2000): the firm’s marginal propensity to switch from resource-intensive to resource-extensive production techniques is likely to depend upon the degree to which its fiduciaries are *aware* of waste options and waste costs.

There are two further fundamental assumptions of the NC innovation school that I consider implausible vis-à-vis eco-innovations: first, the assumption of profit-maximising behaviour and second, perfect information and selection concerning the outcomes of innovation opportunities. The PH suggests that, for eco-innovations in particular, firms are not at their efficiency frontiers. Even if the PH is considered invalid vis-à-vis the contention that win-win scenarios are ubiquitous, it is implausible to argue that there is no scope for pollution offsets. These aforementioned NC assumptions are challenged in the evolutionary economics school, which attempts to provide a more realistic depiction of the workings of the firm’s ‘black box’. The Nelson-Winter models of firm/business environment interactions and the associated ‘search’ and ‘selection’ concepts appear to me to be a plausible explanation of the workings of this ‘black box’, although there has been little empirical testing of their models (Ruttan, 1996). I attempt to test the validity of these evolutionary economic arguments to eco-innovations in Chapter 7.

In the Nelson-Winter models, the NC profit-maximisation assumption is replaced with ‘satisficing’ behaviour. The *status quo* is that the operational agents for this corporate greening are likely to be managers for whom social and environmental issues are an auxiliary, peripheral concern. Further, these operatives are likely to have limited experience of ‘search’ and

‘selection’ routines for eco-innovation as greening is a relatively new corporate phenomenon. I described the Nelson-Winter models above as an adaptation of NC transactions cost theory coupled with expectations-augmented risk-management strategies. The transactions costs associated with R&D and innovation-testing in a new domain are likely to be higher than for well-established innovation areas of competence. On the other hand, the expected private benefits to the firm from eco-innovation searches may be comparably higher *ceteris paribus* if there are increasing returns to scale associated with green searches: this is a technical expression of the ‘low-hanging fruit’ argument of Porter (1991). Given the relatively high uncertainty and associated *private* risk to individual managers in eco-searches, I would contend that ‘satisficing’ rather than optimising better describes managerial behaviour. Managers are then simply heeding advice proffered in the Sixteenth century:

[T]here is nothing more difficult to execute, nor more dubious of success, nor more dangerous to administer than to introduce a new order of things; for he who introduces it has all those who profit from the old order as his enemies, and he has only lukewarm allies in all those who might profit from the new. (Machiavelli, 1950/1513: 21)

The Machiavellian position is further justified in that the time between successive eco-investment iterations/equilibria is generally far longer than the time horizon for significant changes in prices (Winter, 1984). In summary, risk-aversion and ‘satisficing’ seem to be a rational, utility-maximising managerial strategy vis-à-vis eco-innovations.

The Nelson-Winter models share a common theme with Arthur’s path-dependent models in that the firm’s innovation search history matters: new innovations evolve from earlier technical/process developments. I would criticise the Arthur models in that they do not consider the forces that are responsible for the rate and direction of technical change. Although the mechanics of potentially reaching a lock-in outcome are exogenised, the lock-in outcome itself is perhaps relevant to the greening debate. Lahaye and Llerena (1996) postulate that the economy appears to be locked in to a type of development where the extant technologies are polluting and for which policy regulation prescribes the use of abatement technologies or end-of-pipe technologies.

The authors describe the force that maintains the lock in as: “the *positive* externalities developed in the existing dominant technological path” (emphasis added) (Lahaye and Llerena, 1996: 210). I would contend that the externalities are in this case of the *negative* network type discussed in Arthur (1989). Further, it is imprecise to classify the totality of firms as on (and propagating) one and only one “existing dominant technological path” (Lahaye and Llerena, 1996). The only universal ‘path’ is that of the capitalist price mechanism as a means of

allocating resources in society. There are two elements to the innovation ‘lock-in’ which need to be explored in order to ‘operationalise’ corporate sustainability. First, how might the analysis of David (1975) that explores the symptoms of lock-in be modified so as to cure the problem? Although Arthur (1989) refers only to negative network externalities, the next section discusses the feasibility of attaining *positive* network externalities: can industry be locked into a sustainable path? Second, Section 6.7 considers what organisational changes *inside* the firm’s ‘black box’ are needed such that industry avoids becoming further locked into the dominant paradigm, i.e. how might their search mechanisms be adapted. The following section documents the role of the institutional framework in ‘operationalising’ sustainability.

6.6 Institutional change and network inertia

Green corporate inertia exists when firms do not search for and/or implement eco-innovations that increase profits; this can arise from a general resistance to change and/or risk-aversion (Lundvall, 1988). I would categorise green inertia as two types: these might simplistically be termed as first, ‘not knowing’ and second, ‘not responding’.

Robins and Trisoglio state: “most companies still have no idea of the amount of pollution and waste they are producing and thus are unable to undertake elementary assessments to minimise waste and save raw materials” (Robins and Trisoglio, 1992:177). This view might appear now as a little anachronistic given the extent of corporate environmental reporting and accounting activities, as described in Kolk (2000). However, a closer inspection of what is being reported demonstrates that, by and large, companies do not report on resource/environmental conservation, but more on environmental *spending*. This outcome is perhaps endemic to the ‘business of doing business’. End-of-pipe innovations are linked to core scientific and engineering principles that propagate certain search directions. The technology of waste reduction, by contrast, does not have a similarly well-established scientific basis (Friedlander, 1989), although ‘design-for-environment’ is slowly modifying this. To date, there does not seem to have been a wholesale radical shift in the organisational routine through which firms engage in eco-innovations (Lahaye and Llerena, 1996). The incremental processes of the Nelson-Winter models are perhaps more descriptive of eco-change to date. The eco-innovation search/selection path is a punctuated series of equilibria that are ‘good enough’ to pass the profitability threshold of ‘satisficing’ behaviour. Thus, as I stated above, this form of inertia or technological lock-in arises from firms ‘not knowing’ about the potential benefits or radical, visionary change, i.e. searching for a new search process.

Firms evolve not in isolation but as part of networks, and modifications to the players in these networks or how they interact with one another can serve to change this search process; firms

‘co-evolve’ and ‘learn’ as discussed in Section 6.3.2. This co-evolution can be part of the problem in terms of network externalities (Arthur, 1989) but can also perhaps provide a means of ‘operationalising’ corporate sustainability.

Consider first the user-producer network interaction. The firm actually plays out both roles; it is a user for plant and machinery (manmade capital) and (extra-firm) consultancy services; it is producer of the end product that its customers purchase. Lundvall (1988:352) states: “An innovation will diffuse *only* if information about its use value characteristics is transmitted to the potential users of the innovation” (emphasis added). I would contend that information-transmission is not a necessary condition, but an important one nonetheless in most scenarios³². If the innovation is to be sold to an external firm within the network then of course the purchasing firm must be convinced of the efficacy of the eco-innovations and thus information must be transmitted. One reason for inertia is when the network does not function well in diffusing the eco-innovations, even when diffusion is in the interests of the eco-innovator. This might occur because eco-innovations do not have the degree of specificity and differentiation that other competing innovations have (Lahaye and Llerena, 1996), or because of the time needed to develop selective relationships involving elements of hierarchy and mutual trust (Ludvall, 1988). A related issue is the firm’s interaction in its industry network with other firms/competitors. Nelson and Winter (1982) consider that inter-firm learning is a critical dimension of the search process. If a firm’s competitors are not ‘learning’ to adopt radical eco-reform then there is a reduced likelihood of the firm searching for a new search mechanism.

There can also be a network externality effect at play (Arthur, 1989): ‘not knowing’ does not imply that firms are somehow oblivious to the sustainability debate, only that they do not expend the resources on eco-innovation searches so as to locate opportunities for the implementation of eco-change. One important reason for such inertia is inter-firm competition is that there can be a first-mover *disadvantage* for eco-innovation adoption. This is a re-application of David (1985; 1986) of the ‘QWERTY’ keyboard to sustainability. For a firm to expend its R&D resources *ex ante* in the eco-search, it must be convinced that *ex post* private efficiency gains will arise. This *ex post* scenario can depend not only on the private behaviour of the firm but also on the response of the industry (and society) at large. In the case of David (1985), any firm’s impetus to develop and market alternatives to ‘QWERTY’ were hampered by the ‘quasi-irreversibilities’ and ‘technical inter-relatedness’. In terms of eco-innovations,

³² Consider the example of efficiency gains arising from an eco-innovation that is developed and implemented ‘in-house’, for instance a reduction in packaging. In this case, the end-user of the innovation (the customer receiving the packaged products) need not be aware of the eco-efficiency gains in order for the packaging innovation to be successful; further, this eco-innovation might then be diffused throughout the firm.

some modifications to a firm's behaviour might be privately efficient if and only if the rest of the industry follows suit.

Consider the following (hypothetical) scenario. Technological developments in petro-chemicals allow the feasibility of inventing/developing a less carbon-intensive and more energy-efficient substitute to petrol. In order for any oil multinational to sink the resources into the necessary R&D, it must be convinced that the car-manufacturing industry would be willing to adapt to this eco-technology which is incompatible with current car production. Further, it must be able to licence the sale of this substitute fuel to its competitors in order to claw back the sunk R&D expenditure. Owing to the uncertainty of these conditions applying, the eco-innovation might never be developed *ex ante*, even though it is possible that the long-run profitability of the industry would be enhanced by such private eco-investment; this is then a negative network externality. The industry suffers from 'never knows' inertia in that the environmentally friendly option is not developed. Similarly, even if the eco-technology has already been developed, then a 'not responding' inertia might still arise owing to competitors' uncertainties, say over future licensing agreements.

Arthur (1989) proposes that exit from an inferior innovation development path depends on the source of the self-reinforcing mechanisms. Lock-in is due to both "coordination effects" and "learning effects" (Arthur, 1994). In the case of the former, the lock-in is reversible provided that all agents agree to move to the new equilibrium innovation path simultaneously: this relies on there not being any 'quasi-irreversibilities' in the form of sunk investment in specialist non-transferable equipment/training. When such investments are already *in situ* then the learning effect lock-in applies, and it is then difficult to overcome the inertia and move the innovation trajectory. The hypothetical scenario above describes a combination of the two mechanisms. If inertia is primarily induced by learning effects then only state regulation to enforce a change in innovation trajectory is likely to 'operationalise' sustainability.

I would contend that it is likely that a significant proportion of network externalities arise as a consequence of coordination efforts. State intervention of some kind is then optimal to overcome this source of market failure. One impetus for firms to expend the transactions costs associated with 'operationising' a new innovation trajectory for their industry is the *threat* of compulsory legislation. There is a strategic behavioural element to the industry/regulator negotiations, as is developed in Chapter 8: if the industry body is not convinced of the regulator's resolve in 'punishing' non-coordination then corporate inertia might be maintained. Thus, this is an iterative signalling game of imperfect and incomplete information and the optimal welfare-maximising strategy of the regulator is generally then to coerce the industry

into change through the legislative punishment mechanism. The PH contends that stricter legislation might avoid any lock-in to a pollution-intensive trajectory whilst simultaneously improving the private profitability of firms.

If a firm *unilaterally* attempts to change the innovation path towards sustainability then it is likely to bear a disproportionately large share of the industry's (transient) incompatibility costs. There is then economic justification for the state to subsidise/promote such reformist firm behaviour as there is a positive externality for the industry and society at large. Such behaviour can be a pre-cursor to the industry becoming locked into a sustainability path in the long term.

This implies that the regulator should play an active role in the eco-innovation agenda. Irwin and Vergragt note: "The whole issue of regulation, therefore, has been conceptualised as a post innovation check on undesired side effects rather than a tool for directing technology towards socially desirable ends" (Irwin and Vergragt, 1989:58). The ethics of the role of the regulator was discussed above in Chapter 2: if a network externality exists (and thus a market failure) then intervention is optimal not only under Irwin and Vergragt's social network theory but also under neo-classicism. The form and type of legislation and incentives for ameliorating network externalities depend on a host of situation-specific conditions, one of which is functional 'search' routines of the firms in the industry. Other conditions include: the industry structure; the level of environmental R&D in the industry; the state of current legislation; the level of industry participation in determining the regulatory framework; and the scope for eco-reform, i.e. the marginal social and private benefit of eco-innovations.

There is a link between 'network externalities' and Garrett Hardin's infamous 'tragedy of the commons' argument³³ (Hardin, 1968) which refers to common pool resources-management; this link is unexplored in either literature to my knowledge. Hardin's 'tragedy' occurs when there is incentive incompatibility between optimal behaviour in social terms and optimal behaviour in private terms. The 'tragedy' has spawned a significant literature on environmental common-property management, e.g. Hanley and Folmer (1998) which discusses game theoretical applications; Ostrom *et al.*(1997) which documents theories and case studies. The solution to the incentive incompatibility is presented in Hardin (1968) as "mutual coercion mutually agreed upon". This has been tested in the form of a computer-simulated repeated game with a large but finite number of iterations (Axelrod, 1984). Axelrod (1984) finds that (something close to) the private maximising strategy is cooperation with an appropriate

³³ The 'tragedy of the commons' is perhaps the most infamous misnomer in environmental economics. Hardin's 'tragedy' properly refers to the tragedy of open access resources wherein there are no restrictions to entry and resource-exploitation.

punishment mechanism³⁴. Thus, it is possible to overcome the ‘tragedy’ with some appropriate coercive/punishment mechanism.

The analogy to the common property resource for network theory is the industry and the firms within the industry are analogous to the players in the ‘tragedy’. The ‘tragedy’ equivalent for the network externality is that each individual firm in isolation has a private profit-maximising strategy that is to invest in R&D on the dominant (non-green) innovation path. Collective industry-level performance would be improved by a fundamental move from the lock-in, but the unilateral action of any one firm in isolation has an insignificant/economically ‘small’ effect on shifting the industry innovation path. Further, such a unilateral action incurs a private profit-loss. Thus, the optimal behaviour of each and every firm in the industry is to perpetuate the network externality, although the outcome of these private strategies is sub-optimal for the industry. The solution to overcome this incentive incompatibility is some form of industry-wide ‘mutual coercion mutually agreed upon’, i.e. the coordination efforts of network externality theory. As mentioned above, one stimulus for such mutual coercion might come from the threat of legislation in the event of a failure by the industry to self-coerce.

6.7 Organisational change and the firm’s ‘black box’

The previous section considered macro-level innovation path dependence for the industry/society. This section considers micro-level intra-firm inertia to eco-change, viz. an exploration into the firm’s ‘black box’. Further, it is an investigation into the intra-firm innovation process itself as innovations are determined by the way that information is processed and manipulated within the firm: the firm’s organisational structure supports to a greater or lesser degree particular learning processes and knowledge bases. An understanding of how the various functional, manufacturing and marketing departments ‘learn’ in isolation and how they interact with each provides a platform for assessing the inertia of the firm as a whole.

There are trade-offs between what Lahaye and Llerena (1996) refer to as "divisionisation" of and the centralisation of R&D innovation activities. A flat corporate hierarchy generally corresponds with R&D innovations being instigated and managed at divisional level. This is termed an "organic system" by Lahaye and Llerena (1996) as opposed to the centralised "mechanistic system" which are characterised by rigidity and the associated coordination by regulations. The advantage of the former is that innovations are instigated by and thus directly targeted at the end user; there are ‘learning by doing’ benefits. The advantage of the

³⁴ Axelrod applies a repeated game “prisoners’ dilemma”. The best strategy is cooperation but with an occasional random non-cooperative iteration; full cooperation (without randomised non-cooperation) produces a private utility level that is close to this best strategy.

mechanistic system is that certain economies of scale can be realised in that certain innovations are transferable between divisions, and indeed the opportunity for technology transfer is likely to be more visible the less division-specific is the innovation.

The term eco-innovation was defined in Section 5.1 with reference to the entire life cycle of the product. In order to capture potential eco-innovations, the intra and inter-divisional communication channels must be set up appropriately, as the nature of eco-innovations may well differ from other types of innovation. I would contend that an 'organic' system is perhaps a more appropriate hierarchical structure in order for intra-firm inertia to be overcome. This might imply the need for cultural change in the firm.

Corporate culture might be defined as, "a cohesion of ideas, values, norms and modes of conduct, which have been accepted and adopted by the company" (Welford, 1995:114). A great deal has been written in the greening literature concerning cultural change; for instance, 'stage models' (e.g. Hunt and Auster, 1990) concern themselves with 'how to become a green firm'. However, I would support the contention of Gray (1990) and Alvesson and Berg (1992): "[t]here is therefore some reason to regard the corporate culture field as a giant with clay feet - full of concepts, models, theories and speculation, but with a relatively weak empirical base" (Alvesson and Berg, 1992:50).

The underlying assumption of these stage models is that there is a progression line from a firm that is unengaged and disinterested in environmental issues to proactive corporate behaviour, or what might be termed an environmentally responsible corporate culture. The firm can choose the rate of movement up through the stages. Despite some disclaimers, the advocates of stage models (e.g. Roome, 1992) not only state that being at one stage of eco-development is a necessary precursor to progressing to the next stage but there is also the strong suggestion that their particular stage model is the best universal prescription for achieving this.

However, I would contend that the delineation and definition of the individual stages is poor. This is of significance as the quest to achieve the tag 'environmental responsible firm' is often depicted as a well-charted 'road to Damascus' and corporate prosperity, and yet the leading proponents of this vision cannot agree on where exactly the road is located and where the pertinent signposts are (Schaefer and Harvey, 1997). Further, I would contend that the shift from 'environmentally responsible' to 'sustainable' probably adds another order of magnitude of complexity.

Schaefer and Harvey (1997) attempt to 'operationalise' the criteria proposed in two stage models (Roome, 1992; Hunt and Auster, 1990) for four UK water and electricity utilities. These two stage models were selected as they were the only two that were, "sufficiently specified to even attempt a classification of companies" (Schefer and Harvey, 1997:198). The authors found that 'operationalising' the criteria "proved impossible" (*ibid.*). In summary, they state: "none of the four companies displays a profile of characteristics that would place it unequivocally in any particular stage" (Schefer and Harvey, 1997: 200). It is noteworthy that the firms in the research sample categorically labelled themselves as environmentally 'proactive' (stage 5) but the authors only found, "limited change to organisational structures and systems in any of the companies, all of which are supposed to be characteristic of stage 3" (*ibid.*).

I would contend that the various models of intra-firm cultural change appear to be incoherent, both in terms of comparisons between models and even in terms of the applicability and testability of any one model across different divisions in the firm. I would however make the following simple (and perhaps non-radical) proposition: generating an environmental ethos into the innovation process generally requires some form of modification to organisational routines as, aside from perhaps health and safety issues, few innovations are (or indeed ought to be) all-pervasive in the firm, across all divisions. Eco-technologies should affect not only the manufacturing division but also R&D and design ('design for environment'), marketing (eco-labelling), service and repair (interactive knowledge concerning durability and backward-compatibility to reduce product redundancy), accounting (natural resource accounting and 'genuine savings') and personnel (hiring and retaining staff who meet the firm's revised mission statement and ethos). How this change in ethos might be best stimulated by state intervention in terms of stimuli ('carrots' and 'sticks') depends on the particular state of the industry under consideration, and thus needs to be targeted. In all industry sectors there are likely to be firms which are better described as 'organic' and others as 'mechanistic'; certain firms will employ I&We (Etzioni, (1988) stakeholder management with profitability as a means to an end, whereas other firms will attempt to maximise profits. The optimal selection of legislation must embrace this diversity.

6.8 Chapter conclusions

The overall nature of this research is an analysis of optimal legislation for 'operationalising' corporate sustainability. This chapter has documented the analyses of the various innovation schools, none of which are categorically and exclusively concerned with eco-innovations. I would propose that *some* policy guidance should come from treating eco-innovation as a perfect subset of general corporate innovations, as this is indeed the position vis-à-vis sustainability adopted by many firms. However, I would contend that this is not the complete

picture. I have thus attempted in this chapter to modify constructively, criticise and extend the standard arguments in the innovation literature. The aim of this final section is to provide a brief synopsis of the relevance and implications of innovation theories to this research in general and to eco-labelling in particular (*cf.* Chapter 8).

Any eco-innovation process is determined by stimuli from within the firm's 'black box' and from the firm's external business environment. Looking inside the black box, the outcome of any state intervention should be guided by the aforementioned Machiavellian instruction: there must be an incentive for the firm to reward any fiduciary who is attempting to create a 'new order of things' (Machiavelli, 1950/1513). For the late-starter firms (or indeed the non-starters), environmentalism implies a 'new order of things'. Eco-labelling signals to the consumer the green credentials of the firm. An ethically-motivated green manager can then justifiably claim that the promotion of eco-innovations is not only his or her personal agenda but also that of the firm. Further, a properly implemented eco-labelling initiative in the firm should achieve this outcome irrespective of the structure of the management hierarchy, although I would contend that a flatter, more participatory 'I&We' structure (Etzioni, 1988) is more conducive to overcoming intra-firm inertia.

The other form of inertia arises from institutional factors and network externalities. One such institutional factor is the relative prices of factor inputs. This is a significant determinant of the innovation path both under conventional NC models and under evolutionary economic models. Under the NC school, firms instantaneously adjust to a new efficient equilibrium, implementing innovations that decrease the level of natural resource factor input as the relative price of this factor increases. Under the Nelson-Winter evolutionary models (Nelson and Winter, 1973; 1974; 1975; 1982), the threshold profitability constraint that ends the stochastic innovation search process is more likely to imply a reduced throughput outcome if the relative price of raw material inputs is high. Thus, one simplistic policy implication is that the throughput associated with the production process can be reduced through the manipulation of factor prices. However; the effectiveness of such a policy depends on the degree of substitutability between factor inputs.

A firm's demand for factor inputs is a form of derived demand. If green consumers (the end users) demand that the production process become progressively less and less resource and energy-intensive then the implicit price of natural resources and energy inputs rises concomitantly. Thus, the stimulation of eco-labelling schemes can have the same effect as increasing the price of these inputs through taxation, which is much more of a blunt policy tool, as well as being a more politically-sensitive one. Since both neo-classicism and evolutionary

theories purport that relative factor prices matter, removing inefficiencies in eco-labelling is then a viable means of promoting eco-innovations.

I have argued that the Nelson-Winter models of routine-based search behaviour and Simon's 'satisficing' conceptualisation (Simon, 1955; 1959) better describe how firms innovate as compared with neo-classicism, particularly in relatively new innovation domains such as sustainability. Firms co-evolve with suppliers, competitors and customers in their learning networks. Further, according to the influential PH, firms are not perched on the edge of their respective efficiency frontiers vis-à-vis eco-innovations. Thus, legislation (or indeed the credible threat of legislation) to make eco-labelling mandatory across an entire industry can imply a mutually self-reinforcing synergy between firms as they learn from their respective networks, and thus might transform environmentalism into a core corporate concern. This is a form of 'mutual coercion mutually agreed upon' (Hardin, 1968). This outcome is the equivalent to a shift in the Ahmad innovation possibility curve (Ahmad, 1966), such that one iteration towards an eco-friendly innovation generates a decision-making scenario for the firm wherein eco-friendly innovations are more likely to be selected at the next iteration *ceteris paribus*. Legislation to regulate better eco-labelling also serves to reduce the extent of Arthurian network externalities (Arthur, 1989), a form of organisational inertia which is often propagated through 'coordination effects'. If the application of an eco-label signifying environmental and/or social quality of the firm's product/service is a legal requirement from one given date then all the players in the industry that have not 'moved' *ex ante* must do so simultaneously, therein mitigating coordination effects and quasi-irreversibilities (David, 1985).

The application of eco-labelling as a management tool might be criticised as reinforcing the capitalist paradigm of consumerism and profit-orientated firm behaviour. I described the condition for a successful shift to a sustainability-innovation path to be a neo-Schumpeterian 'search for new search routines', wherein the new desired equilibrium is a transformative state that cannot be reached by incremental steps. Although I would accept that the application of the conventional management tools discussed in this research do not constitute a sufficient condition for such a transformation, I would propose that they are virtually a necessary condition for such a fundamental shift. The *status quo* is that environmentalism and sustainability are, by and large, peripheral corporate concerns; I would propose that they first need to become established as *core* concerns on the corporate agenda before they can ever becoming *defining* features of the 'business of doing business'.

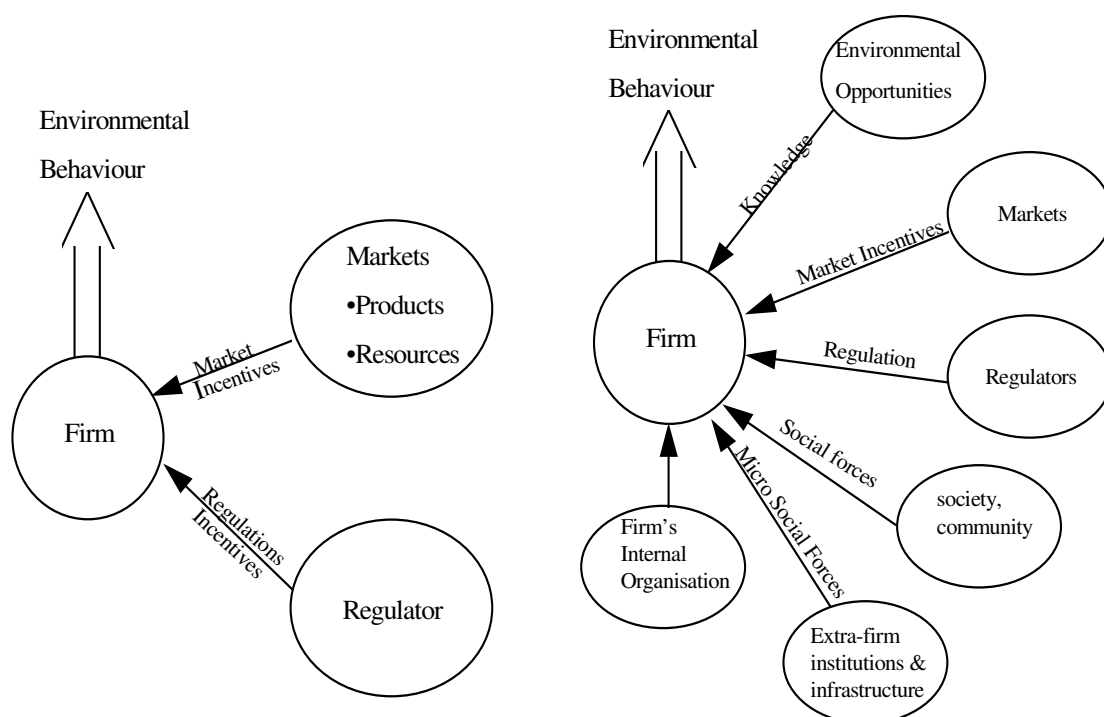
7 ECO-INNOVATION IN PHARMACEUTICALS

7.1 Introduction

This chapter is a modified version of Kusterer and Hussain (2001). It is the second of three applications chapters in this research, the last being an empirical investigation of eco-labelling set out in Chapter 8; both report the findings of postal surveys to (distinct) samples of UK and German producers in the chemicals sector³⁵.

The aim of the empirical study discussed in this chapter is to provide some insight into the *process* of eco-innovation adoption. The previous chapter outlined and critically commented on various competing schools *within* NC and evolutionary economics vis-à-vis eco-innovation. Figure 10 is adapted from Tomer (1992). Although perhaps a simplification, it serves as a broad brush characterisation of the competing viewpoints. The aim of the empirical study documented in this chapter is to test the validity of the NC versus the evolutionary³⁶ models of eco-innovation.

Figure 10 Neo-classical (left) versus socio-economic (right) models of a firm's environmental behaviour (adapted from Tomer, 1992)



³⁵ The constituency of the respondents is distinct as is the nature of the two sub-sectors of the chemicals industry. As such it seems invalid to carry out a comparative appraisal of results across the studies set out in Chapters 7 and 8 and I have not attempted to do so.

³⁶ Although Tomer (1992) refers to a socio-economic perspective, the depiction of factors affecting environmental performance is similar to that of an evolutionary one.

Perhaps the most contentious element of empirical research in this area is the determination of 'environmental behaviour'. The detailed definition of this behavioural variable is given below in Section 7.4 but it is noteworthy that all the components in its designation are through necessity environmental and social management tools and indicators such as the operation of an EMS, environmental accounting, environmental reporting, social auditing *etc.* The implication is that the more tools the firm can 'tick box' then the more sustainable is the firm. The limitations of reporting *versus* performance were discussed above in Section 4.3.1 and apply here. However, corporate confidentiality and an inability therefore to carry out an impartial third-party assessment of the relative greenness of the sample respondents implies the need to fall back on such a methodology. This is a methodology commonly applied in research of this nature, e.g. Andersen, 1998; Angell, 1998; Hunt and Auster, 1990; Roome, 1992.

Despite this caveat, I would contend that this empirical research is an important contribution to the literature on the process of eco-change. The chapter is structured as follows. An economic overview of the pharmaceuticals industry vis-à-vis market and operational structure is out in Section 7.2. The social and environmental issues that pertain to this sector of the chemicals industry are discussed in Section 7.3. The study overview is presented in Section 7.4 and results in Section 7.5. Section 7.6 contains a discussion and conclusions.

7.2 The pharmaceuticals industry: market conditions

The pharmaceuticals sector might be considered a sub-set of the chemicals industry. It is characterised by frequent product and process innovations and intense international competition (EC, 1984). A few large firms dominate the industry, originating in a select few developed world nations, *viz.* France, Germany, Switzerland, the UK, Japan and the USA (EC, 1997). The 1980s saw the delocalisation of relatively low profitability, technologically mature sub-sectors to developing world countries and a concomitant shift to capital-intensive R&D in these developed nations (James, 1990; Achilladelis and Antonakis, 2001; Sherer, 1993). A contributing factor to the overall trend towards greater market concentration and vertical integration was the emergence of successful venture capital-funded biotechnology firms; these were in the most part acquired by pharmaceutical multinationals and their biotech innovations then assimilated into the product portfolio (Galambos and Sturchio, 1998). Achilladelis and Antonakis (2001) depict the pharmaceuticals industry as one that, by the 1990s, had become truly global; they suggest that comparisons among national industries "became largely irrelevant".

The pharmaceuticals market structure is relatively stable vis-à-vis the dominant firms; few significant changes have occurred since the 1980s (EC, 1997). One reason for this is the economies of scale that are due in part to the high costs of product development. This study focuses on Germany and the UK, two of the host countries for the set of dominant TNCs. Table 10 summarises the strength of the UK and German supply vis-à-vis the global market³⁷.

Table 10 The structure of the pharmaceuticals industry structure in 1994

	Number of firms	Number in category of global sales above ECU 1,000 million
Germany	1,200	6
UK	114	3
EU	2,662	15
World	Not available.	48

(adapted from EC, 1997)

The market concentration in the UK (as of 1994) is the highest of any other EC member state and in Germany is the lowest: the market share for the 50 largest companies is 80% and 61% in the UK and Germany respectively (EC, 1997). A further difference between the two nations is that there is a higher proportion of supply by subsidiaries owned outside the host nation in the UK than in Germany, the respective figures being 63% and 47% (*ibid*).

There are significant variations on the demand side of the market as well. Within the EU, the consumption of pharmaceuticals typically represents between 0.5%-1.5% of GDP; Germany is close to the top end of this scale whereas the UK is nearer the lower end (*ibid.*). Such variations are determined by such factors as institutional arrangements, attitudes to drugs and the medical profession in general and other socio-economic and cultural factors, for instance the level of obesity, smoking, diet *etc.*

Innovation and research and development are in some senses defining features of the pharmaceuticals sector. Achilladelis and Antonakis (2001) carry out an extensive survey of innovation in the pharmaceuticals industry between 1800 and 1990, with the analysis of 1736 product innovations (new commercialised medicines). Their study shows there to be a statistically significant positive relationship between innovation and commercial success in the sector. Of those innovations that were adjudged by an expert panel of academics/industrial managers to be 'radical', about 60% were market successes (*ibid*).

³⁷ The figures and statistics in this chapter refer to the state of the pharmaceuticals industry as it was at the time that the study was carried out, i.e.1999. They describe the *status quo* at that time and thus, I would contend, are more relevant than current data.

Only large firms with annual turnover in excess of 1000 million Euros are likely to be autonomous in new product development (EC, 1997). This product development has three stages: first, the identification of product compounds that have the desired physiological effects; second, extensive testing on animals and humans; and third, the chemical entity must be transformed into a functional form suitable for routine administration and large-scale production (EC, 1984).

Taking the industry as a whole, production typically constitutes 30-40% of turnover, R&D some 10-15% and marketing *circa* 15-20% (EC, 1997). The production element is larger for those firms that specialise in the production of generic medications, *viz.* copies of existing products sold by firms other than the originator at reduced prices. Marketing as a proportion of turnover is higher in self-medication ('over the counter') products. Only this product category can be marketed directly to the end user (EC, 1984); the marketing budget for other pharmaceuticals is for direct product promotion to doctors by medical sales personnel and through advertising in the specialist medical press.

The generics market poses a threat to research-based firms. The competitiveness of the former implies that the latter must recoup the R&D costs within the lifetime of a product patent. Further, the monopsonistic buying power of public health care systems and the procurement practice thereof have stimulated the generics market. In general, generics firms compete primarily on cost leadership whereas research-based firms seek competitive advantage through product differentiation (EC, 1997).

7.3 The pharmaceuticals industry: issues pertaining to sustainability

As mentioned above, in manufacturing terms the pharmaceuticals industry is a sub-sector of the chemicals industry. The production processes for pharmaceuticals (and to an extent then the sustainability of the sector) are derived from this. Although the output quantities are generally of an order of magnitude lower than for the chemical industry as a whole (Stoker, 1983), there are still many operational parallels. Further, the large research-based pharmaceutical industry multinationals are frequently, often for reasons of historic development, involved in other branches of the chemical industry. Their product ranges are diverse with a considerable variation in the proportion of company sales accounted for by pharmaceuticals (*ibid.*). After raw materials' production, pharmaceutical production is the second biggest sub-division of the German chemical industry (VCI, 1998a).

In addition to various environmental management efforts, the chemical industry has taken a leading role in voluntary commitment and stakeholder dialogue. With its 'Responsible Care' programme (ICCA, 1999), launched in 1989, the industry committed itself to continuous improvement in environmental protection, product stewardship, employee health and safety, process and distribution safety and stakeholder communication³⁸. However, quantified targets were only first set out in 1993 – four years after the launch of the scheme - and these focused on Health and Safety issues as opposed to sustainability³⁹. With respect to sustainable development, the industry refers to its main contributions as being chemical innovations, particularly in the fields of biotechnology and genetic engineering, and integrated environmental management (VCI, 1998a; VCI, 1998b). Global environmental issues most frequently discussed in pharmaceutical companies' environmental reports are global warming and ozone depletion (KPMG, 1999). However, no quantified emissions reductions pertaining to these issues have been set at industry level.

With respect to the political implementation of sustainability, the chemical industry campaigns strongly for self-commitment and against energy taxes (VCI, 1998b; ENDS, 1999). The EC takes an even more limited view in that the pharmaceutical industry's contribution to sustainable development is defined in terms of the control of potentially dangerous processes, the efficient use of resources, the reduction in emissions and the disposal of unused medicines and packaging (EC, 1997).

The environmental impacts of production are of course only one dimension of sustainability performance. The social and ethical dimensions pertaining to the industry do not appear to be on the corporate agenda. Amongst these are biodiversity, animal ethics, biotechnology, genetic engineering and the impact of consumption (KPMG, 1999). The industry only pays lip service to the issues of inter-generational and intra-generational equity. With regards the latter, Abraham (1995) argues that the research focus on the treatment of Western ailments owing to the ability of Western consumers to pay for such medical advances is evidence of a lack of corporate social responsibility.

Biodiversity conservation is a key element of sustainable development. In addition to the imports of plants for final consumption, there is intermediate consumption of biogenetic

³⁸ Responsible Care was adopted by the British Chemical Industries Association (CIA) in 1989 and by the German Chemical Industry Association (VCI) in 1991. Responsible Care is an obligation for membership in both associations (ICCA, 1999).

³⁹ http://www.cia.org.uk/newsite/responsible_care/iop.htm accessed 24.11.2004. The indicators set out are: lost time injuries; reportable diseases; major reportable incidents; off-site transport incidents; energy use; water (usage per tonne of product produced); hazardous waste (waste produced per tonne of product produced).

resources by the pharmaceuticals sector. The reasons for this intermediate consumption are the decreasing marginal revenues of synthetically developed drugs, improved methods for screening biogenetic materials and an increasing demand for naturally derived drugs (Gebhardt, 1998).

There is a potential market failure if the beneficiaries of biodiversity preservation (in this case the pharmaceuticals firms) do not compensate those that have property rights over this biodiversity (e.g. the Brazilian government with respect to the Amazon rainforest) for its use. There is an opportunity cost to biodiversity conservation in alternative productivity options such as cattle ranching. Without compensation, the economically rational response of the owners of the biodiversity resource is to conserve if and only if the private benefits outweigh the private opportunity cost (Edward-Jones *et al.*, 2000). The bargaining power of the pharmaceutical industry, an ill-defined property rights system, high discount rates in countries that are rich in biodiversity, and incentives-incompatibility in the form of bribery and corruption can lead to biodiversity loss. This is then behaviour by the pharmaceuticals firms that contravenes (or at the least might stimulate the contravention of) the inter-generational and intra-generational principles of sustainable development.

7.4 Study overview

Research articles that investigate the eco-change process in industry might be split into two broad categories. First there are those that use qualitative and/or quantitative methods to assess the *stated* responses of interviewees with regards the motivations for eco-change (e.g. Bebbington and Thomson, 1996). Second, there are those that attempt to stipulate indicators that *reveal* that a firm is at a certain level of sustainability performance (e.g. Bouma and Wolters, 1998; Bennett and James, 1999). Information in the latter case might be obtained through surveys, but the surveys are not attitudinal *per se*. The 'stage models' (e.g. Roome, 1992; Hunt and Auster, 1990) discussed in Section 6.7 are part of the latter category. This categorisation parallels that between stated and revealed preference methodologies used in the economic valuation of the natural environment (Edwards-Jones *et al.*, 2000).

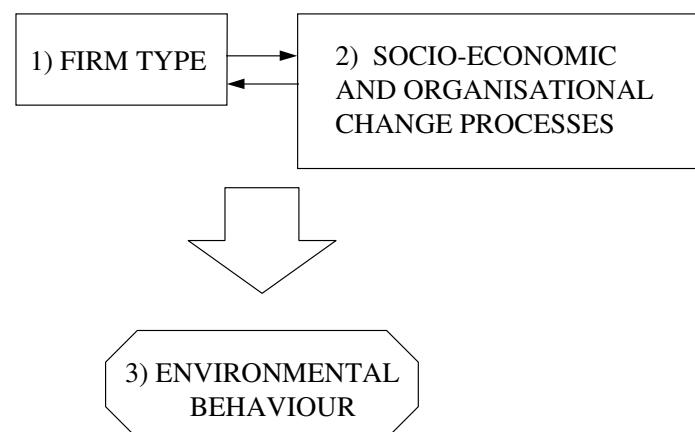
There are fundamental problems associated with both categories of research approach. In attitudinal analyses, there may be some strategic bias in that the survey respondent might be inclined to present the firm's eco-change process and outcomes in a positive (as opposed to a realistic) light. Further, the respondent may not have been personally involved in and/or have first hand knowledge of the eco-change process. There is the potential for systematic bias vis-à-vis the sample in that respondents are likely to have an above-average sustainability performance compared to the industry as a whole. There are two reasons for this. First,

completing a survey is time-intensive and thus those firms that have a specialist (and well resourced) in-house environmental/sustainability management team are more likely to respond than those that have a more piecemeal response to eco-change. Second, since completion of the survey is voluntary, it is more likely that a response will come from a firm fiduciary who feels inclined to flaunt his/her firm's eco-change behaviour.

These problems associated with stated response analyses might suggest that a characterisation of the firm's revealed responses to the sustainability agenda is likely to be superior. However, as discussed in Section 6.7, Schefer and Harvey (1997) find that attempts to use 'stage' models to determine the eco-performance of firms proved to be impossible owing to ill-defined specifications in the models and the fact that, for any one model, firms were at different stages for different eco-performance criteria.

This study of the pharmaceuticals sector does not provide a solution to these systemic problems in researching this area but does attempt to ameliorate them as far as is possible. It uses both stated and revealed information. The research focus is the change process itself and whether the developments in the evolutionary theories in eco-innovations presented in Chapter 6 might explain this change process. A schematic overview of the study framework is presented in Figure 11 and draws parallels from the Tomer (1992) model set out in Figure 10.

Figure 11 Pharmaceuticals industry study framework



The 'firm type' is a composite of firm characteristics that might be termed 'traditional' such as the aggregate sales, number of employees *etc.* The socio-economic and organisational change processes is multi-dimensional and includes various intra-firm and extra-firm stimuli for eco-innovation adoption. The outcome, *viz.* 'environmental behaviour', uses surrogates in the form

of adopted environmental/social management components and indicators. These are set out in Table 11.

Table 11 Innovation study: components of the ‘behavioural variable’

Environmental and social management components
<ol style="list-style-type: none"> 1) Environmental Management System in place 2) Environmental Management System certified 3) Environmental reporting in place 4) Environmental auditing in place 5) Environmental management accounting in place 6) Life Cycle Assessment in place 7) Social reporting in place 8) Social auditing in place 9) Distribution of audit results internally 10) Distribution of audit results externally
Environmental and social indicator components
<ol style="list-style-type: none"> 1) Environmental or social sustainability indicators (SIs) in place 2) Quantitative SIs for resource-uses and emissions in place 3) Quantitative and time-related targets (QTT) established for resource uses and emissions 4) Quantitative SIs for the assessment of production lines and processes in place 5) QTT established for the assessment of production lines and processes 6) Quantitative SIs for environmental or social impacts associated with the life-cycle of products and services in place 7) QTT established for environmental or social impacts associated with the life-cycle of products and services 8) SIs for major <i>environmental</i> impacts associated with the life-cycle of products and services in place 9) SIs for major <i>social</i> impacts associated with the life-cycle of products and services in place 10) SIs for contribution to climate change in place 11) SIs for impact on biodiversity in place 12) SIs for stakeholder relationships in place 13) SIs for human rights in place 14) SIs for impact on animal welfare in place

In this study an equal weight was applied to each attribute. These attributes were selected through the literature review of sustainability in industry discussed in Chapter 4 and the review of items that are/ought to be on the sustainability agenda for pharmaceuticals (Section 7.3). Further, the attribute selection was informed by telephone interviews in June 1999 with representatives of the Association of British Pharmaceutical Industry [ABPI], the German Association of Research-based Pharmaceutical Companies [VfA] and the German Federal Association of the Pharmaceutical Industry [BPI].

I would accept that this formulation of the ‘behavioural variable’ is no better than the measures that arise from the various ‘stage’ models presented (and critiqued) above. However, there is a critical difference with respect to the use made of these indicator components in this study. The ‘stage’ models are both descriptive and *prescriptive*: in essence, an indicator component at one sustainability performance stage must be ‘tick boxed’ before the firm can move up to the next stage. Part of the criticism I would make of these ‘stage’ models is that these prescriptions are not universal, although they are portrayed as such. Thus there is no hierarchy for the components in Table 11; there is no inference that the achievement/application of one particular indicator/management component is a pre-requisite to implementing another.

7.5 Study results

A questionnaire was developed in April 1999 to meet the objectives of the study set out in the previous section. The survey is appended in Appendix 2. This questionnaire was piloted in June 1999 and sent to 150 pharmaceutical companies in July 1999. For the UK sample, all 74 members of the Association of the British Pharmaceutical Industry [ABPI] were contacted by telephone in advance of the dispatch of the postal survey. The ABPI supply more than 90% (by sales value) of the UK National Health Service purchases (ABPI, 1999). The purpose of the telephone contact was to introduce the survey to the company and to allow the designation of the most appropriate person within the firm to complete the questionnaire. A proportion of firms at this stage stated that they would choose not to participate. Thus the UK sample constituted 62 sent postal surveys. The send and reply statistics are presented in Table 12.

Table 12 Send and reply statistics for the eco-innovation adoption survey

	UK	Germany	total
Sent	62	88	150
usable replies	7	25	32
replies total	16	30	46

The same procedure was applied for the German sample. Telephone contact was made with all 37 members of the German Association of Research-based Pharmaceutical Companies (VfA, 1999) and an additional 51 companies that ranked the highest in terms of sales according to information provided by Rote Liste Service GmbH (1997). Overall there were 32 usable responses with a response rate of 11% and 28% for the UK and Germany respectively. Although the UK sample of 62 was lower than the German sample of 88, market concentration is high in the UK: these 62 UK firms constituted approximately 90% of the UK pharmaceutical companies with a production plant in the UK (ABPI, 1999).

The final usable sample showed the following structure in terms of size and operational procedures. 27/32 companies indicated that they were processing pharmaceuticals. From this subset of 27, 12 companies also engaged in raw material production and 15 in retailing. 2/32 respondents were 100% retailing companies. 29/32 were organised on a trans-national basis. The respondents were almost exclusively health & safety and/or environmental managers, with a majority being plant level managers (20/32). The remaining 12/32 respondents answered from the corporate, divisional or country-headquarter perspectives. Table 13 gives a descriptive analysis of the companies' sizes in terms of sales, R&D spending and number of employees.

Table 13 Eco-innovation survey: sales, R&D and employee structure of respondents

Variable		Number of firms
Sales (in EUR millions)	<100	8/32
	100–500	10/32
	>500	10/32
	n/a	4/32
R&D spending (in EUR millions)	no R&D	6/32
	<100	6/32
	>100	8/32
	n/a	12/32
Employees	<250	5/32
	250-500	10/32
	500-5000	10/32
	>5000	7/32

n/a= not applicable/not answered

The firms ranged widely with respect to these variables. The sales range from 15 to 27,500 million EUR. R&D figures were only provided by 20/32 of respondents. These fell within the 10-20% range as a proportion of sales.

7.5.1 Uptake of environmental and social performance criteria

Section II (part 1) of the survey (see Appendix 2) asked respondents to classify the adoption of various defined environmental and social management tools/performance criteria, as set out in Table 14. The responses are disaggregated so as to show the relative adoption rate of members of the Responsible Care Programme which constitutes 56% of respondents (18/32). 75% of the total sample of respondents (24/32) had a certified environmental management system (EMS) in place. Of this subset of 24, 75% (18/24) had been certified under ISO 14001 since, on average, 1998 ($\sigma = 1.2$, $N = 18$) and 50% (12/24) under the EC Eco Management and Audit

Scheme [EMAS] since, on average, 1996 ($\sigma = 1.1$, $N = 12$). As of August 1999, the European EMAS register listed 66 sites for pharmaceutical companies in Germany, and none in the UK; this demonstrates that the sample had environmental performance above the industry average.

Table 14 Eco-innovation survey: the uptake of environmental and social management procedures

Management procedures	Proportion of total sample	Proportion of RC members	year of uptake (mean, standard deviation)
Environmental management system	75 % (24/32)	89 % (16/18)	1995 (2.2), N=24
Environmental reporting	88 % (28/32)	100 % (18/18)	1994 (2.4), N=28
Environmental auditing	81 % (26/32)	100 % (18/18)	1995 (3.2), N=26
Environmental management accounting	53 % (17/32)	78 % (14/18)	1993 (4.5), N=17
Life cycle assessment	31 % (10/32)	44 % (8/18)	1995 (1.8), N=10
Social auditing	25 % (8/32)	39 % (7/18)	1996 (1.5), N= 8
Social reporting	28 % (9/32)	44 % (8/18)	1994 (3.0), N= 9

RC = Responsible Care

N = number of respondents

This outcome would be expected for two reasons. First, the proclivity of higher performance firms to respond is greater. Second, the sample selection systematically targeted larger firms; since there are likely to be economies of scale vis-à-vis the start-up costs for applying these tools, larger firms are then likely to show a higher adoption rate *ceteris paribus*. The fact that the sample is not stratified so as to represent the industry overall may be of some consequence with regards generalising extrapolating from the outcomes and formulating generic policy recommendations. However, as discussed above, owing to market concentration, the firms selected for the UK postal survey supply *circa* 90% (by sales) of the UK National Health Service total pharmaceuticals spend.

The results show that the adoption of eco-management tools by the Responsible Care Programme members was significantly higher than that of non-members. The main reason stated in the survey responses for non-participation in the Programme was that the firm's activities did not include chemical synthesis therein implying that the Programme was deemed inapplicable to them. However, it is noteworthy that 47% (8/18) respondents that stated that their firms were not engaged in raw material production were Programme members. Raw

material production and synthesis is not a pre-requisite of Programme membership. It is difficult to draw firm conclusions from this outcome in terms of causality, *viz.* does Programme membership lead to higher adoption? In the same way that Programme membership was perceived by some respondents to be inapplicable to their firms, similarly the use of one or more of the management tools might have been perceived as superfluous given the extant monitoring and control systems and the nature of the firm's production process.

Of the 10/32 firms that were using LCA as a management tool, 80% (8/10) reported that results were used for new product development, i.e. Design for Environment. Of those using Design for Environment, half (4/8) stated that only partial LCA was applied. The application of LCA is interesting in that it is the tool most commonly applied to set standards in voluntary eco-labelling schemes, discussed in the Chapter 8.

With regards the willingness to distribute the results of management tools applied, 77% (20/26) of firms that conducted environmental and/or social audits stated that they distributed results internally, whereas only 31% (8/26) distributed them to external stakeholders. (All firms that applied social auditing also applied environmental auditing.) This is an interesting result with regards this research in that external distribution might assist consumer decision-making but, owing to the fact that both applying the tool and disclosing the outcomes of its application are voluntary, this potential social benefit is not realised.

Whereas Section II (part 1) of the survey asked the respondent to designate the use of environmental and/or social performance management tools, part 2 asked them to consider indicators⁴⁰. 84% (27/32) of respondents indicated that they were using such indicators and 59% (19/32) stated that they intended to increase the use of such indicators in the future. The designation of when indicators were first used for the sub-sample (27/32) that were using indicators was less well defined than that of EMS applicants: 78% (21/27) responded and had been using indicators since, on average, 1993 ($\sigma=5.1$, $N=21$). One respondent had used indicators since 1980. Table 15 summarises the responses.

⁴⁰ This distinction is to an extent arbitrary in that some indicators are embedded within management tools such as environmental reports. Further, the generic use of LCA as a management *tool* is not independent from its use as an *indicator*; the distinction here is whether LCA application is *ad hoc* or used systematically as a performance indicator..

Table 15 Eco-innovation survey: use of production and process indicators

Indicator area	Proportion of total sample
Resource-use and emissions/discharges	78 % (25/32)
Assessment of production lines and processes	66 % (21/32)
Major impacts associated with the life-cycle of products and services	19 % (6/32)

There are three levels of indicator use set in the survey. In ascending order of eco-performance, they are as follows: the exclusive use of qualitative indicators; the application of quantitative indicators without a time threshold; and quantitative indicators with a time constraint. 78% (25/32) applied some form of indicator to monitor resource use and emissions targets. Of these, 96% (24/25) used quantified indicators and 76% (19/25) used time-specific quantitative targets. The respective figures for the ‘assessment of production lines and processes’ indicator are 66% (21/32), 76% (16/21) and 57% (12/21) and the respective figures for the ‘major impacts associated with the life-cycle of products and services’ are 19% (6/32), 33% (2/6) and 17% (1/6). The responses to the latter formed perfect subsets of responses to the former. For instance, both respondents (2/6) that used quantitative life cycle impact assessment (but non time-specific) also were part of the subset (16/21) which used quantitative non time-specific tools in general. This level of heterogeneity in responses is useful with respect to the survey methodology as it feeds into different levels of ‘environmental behaviour’ across the firms, as per Figure 11 and the associated discussion.

The final part of Section II of the survey considers the application of indicators beyond organisational and eco-efficiency aspects of production: Table 16 summarises the results for these indicators.

Table 16 Eco-innovation survey: use of sustainability indicators

Sustainability area	Number of firms that have indicators in place	Number of firms that have indicators planned
Major <i>environmental</i> impacts associated with the life-cycle of products and services	13% (4/32)	25% (8/32)
Major <i>social</i> impacts associated with the life-cycle of products and services	6% (2/32)	19% (6/32)
Contribution to climate change	9% (3/32)	22% (7/32)
Impact on biodiversity	9% (3/32)	6% (2/32)
Stakeholder relationships	6% (2/32)	16% (5/32)
Human rights	3% (1/32)	6% (2/32)
Impact on animal welfare	6% (2/32)	9% (3/32)

As had been anticipated from the review, the use of indicators such as ‘human rights’ issues, ‘climate change’ impact *etc.* was low in the sample. However, their inclusion in the survey allowed a greater variation in the comparative eco-performance of the sample vis-à-vis the dependent ‘behavioural variable’.

7.5.2 Types of and the timing of eco-changes adopted

Part III of the survey asks the respondent to consider the circumstances and nature of particular change(s) that the respondent designates. This section of the survey is qualitative in nature. 27/32 respondents provided information and described, in total, 60 separate changes that affected the eco-performance of the firm⁴¹. These changes fell into four broad categories: *operational* (30/60); *organisational and strategic* (13/60); *compliance-driven* (11/60); and *stakeholder-driven* (6/60).

The most commonly cited *operational* changes were resource and cost savings in terms of energy, water and waste operations (20/30). 6/30 respondents cited changes to operational procedures linked to site closures, changes to extant premises or new plant construction. With respect to *organisational and strategic* improvements, 7/13 respondents cited the

⁴¹ Note that the exact wording for Section III question 1 on the survey, appended in Appendix 1, was as follows: “Please outline *the* most significant ‘eco-change’ for your firm and specify the time or the time period when it occurred” [emphasis added]. Many respondents chose to outline more than one single eco-change. This implies some procedural problems in analysis in that questions 2-4 that follow ask the respondent to comment on “the change”. When piloting the survey, respondents cited one unique eco-change.

implementation of an EMS and 4/13 strategic policy changes towards sustainability. Only one respondent of the 13 referred in this respect to the parent company's influence, although 82% (26/32) of the respondents indicated that the environmental strategy was determined by their parent companies. Reference was made to explicitly *compliance-driven* changes by 3 German companies in the context of the Unification Act of 1990 which required the creation of equal standards of living across Germany as a whole. In the *stakeholder-driven* category, 2/6 respondents documented a proactive strategy that aimed to increase external stakeholder dialogue and involvement in the firm's eco-performance; 4/6 respondents cited the firm's involvement in improving social conditions (both internally and in the wider community) for its employees.

I have classified the 60 responses into these four groupings for ease of exposition and I would accept that the classification is somewhat *ad hoc*. For instance, it is reasonable to assume that all changes cited are at least partially induced by regulation (or the threat of regulation). Further, there is an overlap between operational changes and organisational and strategic improvements. The reason for categorising the responses in this section as a separate grouping is that the 11/60 respondents *specifically* referred to compliance and to provide a broad synopsis. Section IV of the questionnaire was designed to quantify the relative influence of this and other socio-economic factors.

One of the objectives of Section III was to provide an empirical test of the evolutionary economic debate as to whether the eco-change process is better characterised as *continuous* or *sudden*. 'Sudden' applies to one-off events whereas 'continuous' implies that change is part of an adaptive learning process. As discussed in Section 6.3.2, the Nelson-Winter models might be characterised as "punctuated equilibria" with each search process leading to a new temporary equilibrium through iterative steps. Under the evolutionary economic world-view, the history/path of innovations determines the likelihood of a potential change option being adopted; there is a continuous eco-change process. Under neo-classicism, firms are on (or are close to being on) their efficiency frontiers and thus only a sudden shock can shift the system equilibrium.

With respect to the timing of the eco-changes events cited, of the sub-set of 27/32 that cited at least one eco-change, 56% (15/27) categorised the change as a "programme of change", 26% (7/27) as "combination of programme and one-off" and 18% (5/27) as "one-off". Respondents in the latter group almost exclusively (4/5) cited environmental legislation as the trigger. Although the sample size is small, the results do to an extent validate the evolutionary economic world-view.

Questions 3 and 4 in Section III of the survey, in asking the respondent to cite “stumbling blocks” and “learning experiences”, provide the opportunity to investigate the process of change under a finer resolution than the broad-brush categorisation of continuous versus sudden. This is an empirical investigation into the ‘black box’ of the firm discussed in Section 6.7. Table 17 categorises the responses.

Table 17 Eco-innovation survey: stumbling blocks and learning experiences arising from an eco-change

	Number of responses
Stumbling blocks	70% (19/27)
Lack of human and/or financial resources	37% (7/19)
Lack of interest from colleagues	16% (3/19)
Regulation too stringent and/or inflexible	21% (4/19)
Other	26% (5/19)
Means of overcoming stumbling blocks	41% (11/27)
Staff training and dialogue	55% (6/11)
Use of external consultants	18% (2/11)
Co-operation/dialogue with regulatory authorities	18% (2/11)
Other	9% (1/11)
Learning experiences	74% (20/27)
Transferring the learning experience within the corporation	40% (8/20)
Knowledge-transfer to extra-firm stakeholders	25% (5/20)
Organisational improvements	20% (4/20)
Other	15% (3/20)

With regards stumbling blocks, 37% (7/19) of this sub-group cited resource constraints. Under the NC world-view of optimising (or near optimising) firm decision-making, resource constraints would be a stumbling block if and only if the expected net present value of the proposed eco-change were to be negative. However, under ‘satisficing’ behaviour (Simon, 1959) and the Nelson-Winter models, resources might be pre-allocated for R&D ‘search’ activities that are non-environmental, linked to the firm’s history of innovations. In such situations, resource constraints vis-à-vis eco-change might apply. 22% (4/19) cited a lack of regulatory flexibility and/or regulatory stringency as a stumbling block, although 2/4 overcame this obstacle through dialogue with the regulator. This outcome is consistent with the PH in that Porter (1991) claims that extant inflexible regulation reduces the opportunities for pollution offsets. Further, the Friedmanite NC ethical position, discussed in Chapter 2, would not permit such collusion between the regulator and the regulated. This implies in turn that this obstacle might not have been overcome for the 2/4 and thus these two eco-changes might not have been

realised. On the other hand this regulatory capture might have had adverse social consequences that were not expounded in the survey.

With regards learning outcomes, 40% (8/20) stated that there had been intra-firm knowledge transfer. Knowledge transfer does not however necessarily lead to a future change in intra-firm innovation searches, i.e. the *impact* of this knowledge transfer is what counts. This was analysed in more depth in Section IV of the survey. However, 4/20 responses cited 'organisational improvement' implying some direct positive impact from the eco-change.

7.5.3 Socio-economic change factors

Section IV of the survey asked the respondents to designate the relative importance of different socio-economic factors in inducing continuous and/or sudden eco-change. These variables were grouped into seven categories: regulation; voluntary agreements; technology; markets and competition; inter-firm cooperation; extra-firm stakeholders; intra-firm stakeholders. Table 18 summarises the findings, presenting results both for individual specified variables and by category. In each category, the composite variable is an unweighted average of the individual components.

The results show that the most significant factors are regulatory, both at national and EU level, each scoring a mean of 5.7/7. 'Technology' also scores highly (mean 5.0/7). These are perhaps unremarkable outcomes given that the industry is highly regulated and research-driven. However, it is noteworthy that only 22% (7/31) of respondents considered regulation (the composite variable) to have affected only a 'sudden' change; for 'technology' the respective figures is even lower at 13% (4/31). This is an interesting outcome in that the adoption of eco-innovation owing to regulation is generally considered to be *reactive* (e.g. Welford, 1995); it appears from the responses that such a depiction is a simplification. The scenario for pharmaceuticals at least appears to be an omnipresent 'climate' of regulatory stringency that in turn stimulates a process of searching for eco-change options perhaps in anticipation of further stringency. Further, a comparison of the national/EU regulatory variables with the 'voluntary agreements' variable (means of 5.7/7 versus 4.4/7 respectively) seems to support the Porter contention that firms achieve eco-performance improvements when regulation compels them to do so.

Table 18 Eco-innovation survey: factors affecting eco-change

Variable	Means (range = 1-7)	Perception of change (% of respondents)		
		1	2	3
Regulation, composite variable	5.2 (1.3), N = 31	57	22	20
Regulation, national	5.7 (1.5), N = 31	48	28	24
Regulation, EU	5.7 (1.3), N = 31	56	26	19
Regulation, international	4.3 (2.0), N = 31	68	14	18
Voluntary agreements with regulator	4.4 (1.6), N = 31	87	9	4
New Technology	5.0 (1.6), N = 31	75	4	21
Markets and competition	3.9 (1.3), N = 29	63	27	10
Competition, national	4.4 (1.7), N = 28	71	14	14
Competition, international	3.8 (1.8), N = 28	74	11	16
Changes in prices for production inputs	4.2 (1.8), N = 28	46	46	8
Emergence of new industry niches	3.1 (1.8), N = 26	62	38	0
Demand/supply chain	4.2 (1.2), N = 30	62	26	12
Inter-firm co-operation (within industry)	3.8 (1.4), N = 28	86	10	5
Shift in needs/values: national customers	5.0 (1.6), N = 30	43	39	17
Shift in needs/values: international customers	4.6 (1.7), N = 27	45	35	20
Shift in needs/values: suppliers	3.4 (1.7), N = 28	72	17	11
Shift in needs/values: distributors	4.0 (1.8), N = 28	64	27	9
External stakeholders	4.0 (1.3), N = 29	49	29	22
Shareholders	4.5 (2.1), N = 28	53	18	29
Financial service providers	3.4 (1.7), N = 24	62	23	15
Insurer	4.1 (1.6), N = 27	42	47	11
NGOs	3.8 (1.7), N = 29	45	30	25
Local community	4.0 (2.1), N = 29	45	35	20
Intra-firm organisation	4.8 (1.3), N = 29	50	27	23
Employees	5.1 (1.3), N = 29	58	8	33
Change in firm premises	4.7 (2.0), N = 26	61	22	17
Change in upper management	4.4 (2.0), N = 25	38	44	19
Change in organisation	4.4 (1.7), N = 25	41	35	24
Overall	4.5 (1.0), N = 32	58	25	17

N = number of respondents

1 = continuous change

2 = sudden change

3 = combination of continuous and sudden changes

The extent to which ‘market and competition’ affects the adoption of eco-change is lower than the regulatory composite variable (3.9/7 versus 5.2/7). National competition is the most

significant factor within this grouping. The ‘emergence of new industry niches’ variable only scores 3.1/7. This results support the proposition (see Section 4.3.3) that some of the greening literature has been didactic and over-optimistic. For instance, I cited above Schot and Fischer:

new [‘green’] markets will become more articulated and visible...existing competitors or new firms will innovate and gain competitive advantage. (Schot and Fischer, 1993:14)

The survey results indicate that new green markets have not, for the pharmaceuticals sector at least, become articulated and visible to the extent that the authors’ predictions suggest. With regards the variables linked to demand/supply chain, it is clear that eco-change is significantly affected by and responsive to national consumer needs and expectations (5.0/7). This is an interesting (although predictable) outcome for this research as I consider the economic optimality of eco-labelling and the associated capacity of green consumerism to stimulate improvements in eco-performance.

In the ‘external stakeholders’ category, the highest score (4.5/7) is for shareholders. This is sympathetic with the Friedmanite NC world-view (set out in Chapter 2). On the other hand, there is some evidence of wider stakeholder management and thus potentially corporate social responsibility⁴² and the validity of the socio-economic worldview presented in Figure 10. For both the ‘NGO’ and ‘community’ variables there were 29/32 responses; they scored 3.8/7 and 4.0/7 respectively.

The strongest factor in the ‘intra-firm organisation’ grouping is eco-change suggestions made by ‘employees’ (5.1/7). One respondent for the ‘change in upper management’ variable noted that the eco-performance was *worsened* after the managerial change occurred.

Turning to focus on the rate of change associated with the different variables, overall only 17% of the eco-change factors were described as being just ‘sudden’ and discontinuous; 25% were described as a combination of continuous and sudden and the majority (58%) as part of an ongoing process of eco-change. This is an *overall* average across all the socio-economic factors listed in the survey. The results are very similar those for the designation of the *single* eco-change described in section III of the survey, viz. 56% (15/27) stated “programme of change”, 26% (7/27) “combination of programme and one-off” and 18% (5/27) “one-off”. This once more supports the evolutionary economic perspective on the eco-change process.

⁴² Since the survey asked for eco-change *outcomes* and the stimuli for them as opposed to *intention*, i.e. what happened and not why it happened, it is possible that the positive scores for the various external stakeholder variables are merely the result of the perceived influence of these stakeholders on the ‘bottom line’ of profitability.

The Germany/UK country comparison is subject to the caveat that the UK sample was small. Given this caveat, there was a higher significance score for national and EU regulation for the UK firms (6.1/7 and 6.0/7 respectively) as compared with the German sample (5.6/7 for both types of regulation). The German sample means for voluntary agreements and new technology (4.6/7 and 5.2/7) was higher than the UK sample means (3.7/7 and 4.3/7).

7.5.4 Explaining green innovation adoption

The study overview was presented in Figure 11 above, *viz.* the hypothesis that a firm's eco-performance might be explained by considering both traditional firm characteristics and socio-economic factors. Table 11 lists the elements that form the composite eco-performance 'behaviour' variable. This section presents the results of the correlation analysis that was undertaken to test the aforementioned hypothesis⁴³. In each case, sub-groups were created from the main sample and two sample T-tests carried out to compare the sub-group means for the eco-performance 'behaviour' variable. In each case the null hypothesis is that 'no significant difference exists between sub-groups'.

Traditional firm characteristics

If there are economies of scale associated with the adoption of eco-innovations then larger firms would have higher eco-performance *ceteris paribus*. For the 28/32 responses for sales and the 32/32 responses for employee numbers, three sub-groups were created (high, medium, low). Each sub-group was then compared to the other two appropriate sub-groups. The null hypothesis could not be rejected for any of the 6 comparisons at the $\alpha=0.1$ confidence level.

Track record of eco-innovations

If the adoption of eco-innovations is a path-dependent process then firms that were 'early adopters' are likely to show higher eco-performance 'behaviour'. The adoption of an EMS was used as a test. Three sub-groups were created: 'non-adopters'; adopters that started applying EMS before the mean (1995) for the sub-sample of EMS adopters, i.e. 'early adopters'; adopters that started after 1995, i.e. 'late adopters'. For the comparisons between 'non-adopters'/'early adopters' and 'non-adopters'/'late adopters' the null hypothesis could be rejected at the $\alpha=0.05$ confidence level. For the 'early adopter'/'late adopter' comparison, the null hypothesis could be rejected at the $\alpha=0.1$ confidence level. Another element of path-dependency is whether or not firms *learn* from previous eco-innovation adoptions. Two sub-

⁴³ The intention was to carry out factor analysis but the low number of usable responses precluded this option.

groups were thus formed: the 20/32 that cited a learning experience and the 12/32 that did not. In this case, the null hypothesis could be rejected at the $\alpha=0.05$ confidence level.

Participation in Responsible Care industry-level programme

In creating two sub-groups (participants in Responsible Care Programme/non-participants) the null hypothesis could be rejected at the $\alpha=0.05$ confidence level. However, the result does not necessarily imply causality, i.e. participation does not necessarily lead to higher eco-performance. The survey did not question why participants in the Programme had chosen to sign up, only why non-participants had chosen *not* to do so. There may be self-selection at play in that firms that have already achieved the various requirements set out by the Programme choose to join it. However, this outcome might support the argument that Responsible Care Programme is a type of *labelling* scheme, the subject of the next chapter.

'Programme' of eco-change versus 'one-off' eco-changes

Firms that depict their eco-innovation changes as being the outcomes of a continuous programme as opposed to one-off sudden events are, according to Nelson-Winter models in evolutionary economic theory, more likely to 'search and select' eco-innovations and thus more likely to show higher eco-performance. This was explored in different ways using the survey data. Using the respondents' assessments of the most significant *single* eco-change (Section III of the survey), the null hypothesis could be rejected in this case ('programme'/'one-off') at the $\alpha=0.1$ confidence level⁴⁴. T-tests were also carried out to test whether there was a significant difference in the sub-group means for 'continuous' versus 'sudden' change for each of the socio-economic factors listed in Table 18. Table 19 presents all the factors for which the null hypothesis could be rejected at $\alpha=0.1$ confidence level or better; those factors for which the null hypothesis could not be rejected at $\alpha=0.1$ are omitted for ease of exposition.

Table 19 Eco-innovation study: socio-economic factors and 'continuous' versus 'sudden' change

Socio-economic factor	Behaviour mean 'continuous change' group (range 0-24)	behaviour mean 'sudden change' group (range 0-24)	level of significance α
National regulation	12.1	4.9	1%
EU regulation	12.4	4.3	1%
Emergence of new industry niches	13.4	5.0	1%

⁴⁴ The sub-groups in this case were small in that there were only 27 responses in total (Section III question 2) and, of this grouping, 26% (7/27) described the eco-change as "combination of programme and one-off" and thus these responses were excluded. The same methodological caveat, viz. the need to exclude the 'combination' responses, applies to the significance tests ('continuous' sub-group *versus* 'sudden' sub-group) for each individual socio-economic factor.

Consumer	11.3	5.0	5%
Local community	12.4	7.4	6%
Change in upper management	5.1	11.3	5%

The ‘change in upper management’ variable is anomalous in that the sub-group behaviour mean for ‘sudden change’ is higher than for ‘continuous change’. However, the greening of industry literature (e.g. Welford, 1995) would predict that such a one-off sudden shift might then propagate eco-reform if the outgoing upper management did not have sustainability on its agenda and the new one did.

Although the strength of the outcomes is limited by the response rate, the results in general do seem to support the contention that ‘search and select’ eco-change as a continuous process achieve a higher environmental performance as measured by the ‘behaviour’ variable. I would restate the caveat that constituent elements of this behavioural variable are merely objective management tools/protocols/policies that do not unto themselves necessarily imply ‘good environmental performance’.

7.6 Chapter summary and discussion

The broad aim of the study was to explore the eco-change process for the pharmaceuticals industry and therein both to test the *descriptive* accuracy of NC versus evolutionary models and to provide a *prescriptive* policy appraisal vis-à-vis how to stimulate eco-change. The response rate for the survey was lower than anticipated and the strength of the outcomes was commensurably compromised.

Before turning to the discussion of the analysis *per se*, a caveat should be applied. The characterisation of the NC worldview versus the socio-economic alternative (borrowed from Tomer, 1992) is a ‘broad brush’ one, *viz.* neo-classicism eschews stakeholder dialogue and extra-firm influence from institutions and that the firm’s internal organisation is of no consequence vis-à-vis the firm’s environmental behaviour. There is a link here to the discussion in Chapter 2 on corporate social *responsibility* versus *responsiveness*: if on-going stakeholder dialogue increases profitability then such firm engagement with extra-firm actors serves the twin ends of responsibility and responsiveness and thus does not contravene the NC description of firm behaviour.

This caveat aside, under neo-classicism firms are assumed to be on or close to being on their efficiency frontiers if the market is competitive and thus an eco-change would be adopted owing to a sudden shock to system equilibrium. When asked to designate the most significant eco-change in the firm, only 18% (5/27) described this change as a “one-off”; the global mean

across all 23 designated variables that affect eco-change ('national regulation' *etc.*) was 25% for "sudden change". Further, 37% (7/19) cited resource constraints as a stumbling block, a result that challenges the presumption that firms are indeed perched at their efficiency frontiers vis-à-vis the uptake of opportunities for eco-reform. In summary, the study results support my contention, set out in Chapter 7, that the evolutionary worldview is more empirically descriptive than the NC alternative, although the results are not unequivocal in this regard.

Turning to the prescriptive element, most significant variables were national and EU regulation (5.7/7 in each case). This is an important outcome for this overall research as it is concerned with voluntarism versus mandatory legislation. The 'stick' of regulation is clearly felt whereas the 'carrot' in the form of 'emergence of new industry niches' is less potent, having the lowest score of any variable tested (3.1/7). The PH suggests that stricter (well-designed, flexible) regulation is needed to achieve pollution offsets. Although this survey considered only eco-performance and not the associated impacts on profitability, the results do support the contention that the regulatory 'stick' can motivate eco-change. Porter argues that such legislation stimulates first-mover advantage in environmental technology development. Again, the survey results support this in that 'early adopters' show a higher performance vis-à-vis the behavioural variable than 'late adopters' and 'non-adopters'. Further, those firms that stated that they gained 'learning experience' had a higher eco-performance.

What is also noteworthy is that removing 'shareholders' from the external stakeholder grouping gives a low composite variable score of 3.8/7 (financial service providers; insurer; NGOs; local community). Further, two other variables that are listed under demand/supply chain but that equally represent external stakeholders, *viz.* shift in needs/values of suppliers and distributors, have low significance scores of 3.4/7 and 4.0/7 respectively. Much is made in the greening of industry literature of the effect of such peripheral stakeholders in bringing about eco-change. The survey results suggest that these stakeholders are perhaps not as yet strongly influential.

One other variable that might be termed a stakeholder is 'shift in needs/values: national consumers'. The score for this is quite high at 5.0/7. The results of this survey suggest then that green consumerism is quite a significant force already and, as I argue in the next chapter, might become more significant were market conditions to be modified.

8 THE ECONOMICS OF ECO-LABELLING

8.1 Introduction

Schemes to certify and label products and/or services in some manner or form have been instigated by industry, NGOs and governments since at least the 1970s (Hussain and Lim, 2000). There is a great deal of discrepancy between schemes both in terms of aims and objectives and in application issues. Eco-labels are intended to inform the consumer, at the point of sale, about one or more of the ecological and/or social attributes of that product during the product's life cycle (Karl and Orwatt, 1999). The OECD interprets the goals of environmental labelling as follows: improving the sales or image of a labelled product; raising the awareness of consumers; providing accurate information; directing manufacturers to account for the environmental impact of their products; protecting the environment (OECD, 1991). The US Environmental Protection Agency (EPA) carried out a comprehensive examination of the attributes of eco-label schemes across different countries and found that this OECD interpretation to be internationally recognised (EPA, 1998). Eco-labelling is part of an environmental assurance approach and is dealt with as such under the International Organisation for Standardization (ISO) ISO14020 series.

Eco-labelling might be considered an extension of conventional marketing practices, a profit-driven response by industry to the commercial pressures of green consumer-consciousness. Peattie defines green marketing as “the holistic management process responsible for identifying, anticipating and satisfying the requirements of customers and society, in a profitable and sustainable way” (Peattie, 1992:11). If this definition is adopted then eco-labelling is simply a form of media that communicates information to a receptive user on the impact of a firm's product on the natural environment compared with those of its competitors. This is very much an anthropocentric ‘business-as-usual’ interpretation of what eco-labelling implies. It has been criticised by Welford (following and developing the arguments of Coddington, 1993) who describes it as a “marginalist” approach that “invites companies to pay lip-service to environmentalism” (Welford, 1995:152). Welford proposes a more radical alternative ecocentric approach to marketing under the sustainability paradigm⁴⁵: “if our ultimate aim is sustainable development all other demands must be considered as secondary to this and profit-centered strategies replaced by more holistic and integrated approaches” (Welford, 1995:154). It is noteworthy that such “marginalist” approaches as those of Peattie (1992) have been endorsed and propagated by many influential corporate bodies, such as the Confederation of British Industry (Blaza, 1992). The conservative Peattie definition is adopted

⁴⁵ See Section 2.3 for a discussion of stakeholder management and the associated ethics of firm behaviour.

in this research as opposed to one that might better lend itself to a neo-Schumpeterian radical ‘transformative’ equilibrium shift, *viz.* perhaps green consumerism should be concerned not with consuming the most eco-friendly alternative but simply *not consuming*⁴⁶.

I argue in this chapter that there is an enormous potential for eco-labelling to propel the sustainability agenda but that the market is not currently functioning optimally. The fundamental issue here is that there is asymmetric information, *viz.* the producer is likely to be better informed about the eco-performance of its products than the consumer. The consumer to some extent responds to the marketing messages sent by the firm. However, there is an incentive for firms to send misleading and/or false marketing messages to consumers with respect to eco-performance, a phenomenon known as ‘greenwashing’ (Rockness, 1985). If the consumer cannot discriminate between valid messages and greenwashing then a market failure occurs.

The aim of this chapter is to draw out this argument and its implications and is structured as follows. Section 8.2 outlines the economic foundations of green consumerism, *viz.* the Lancaster-Rosen approach to product attributes; this section thus provides a perspective on consumer decision-making. Section 8.3 then turns from the demand side to the supply side and evaluates firm decision making vis-à-vis the labelling of environmental performance. Section 8.4 discusses the development and designation of different types of eco-labelling schemes and compares the major extant third-party verified schemes. A novel strategic behavioural model of firm/consumer interaction is then developed in Section 8.5. Section 8.6 presents the results of a study which elicited attitudinal responses to eco-labelling. Section 8.7 provides discussion and chapter conclusions. Sections 8.2-8.4 are adapted from Hussain and Lim (2000) and Sections 8.5 from Hussain (2000).

8.2 The Lancaster-Rosen approach and green consumerism

The fundamental driving force of eco-labelling is green consumerism. This section thus evaluates theoretical perspectives vis-à-vis decision-making by consumers. Green consumerism might be defined as the purchase of a good or service that has a level of environmental/social impact that the consumer (rightly or wrongly) perceives to be low relative to competing goods/services in that product category. Williams (1982) breaks this process down into four sequential steps: problem perception; deliberation; solution; and post purchase review. These various steps are documented in the marketing literature (e.g. Howard and Sheth, 1969).

⁴⁶ See Section 6.3.2 for a discussion of ‘transformative’ versus incremental eco-innovations. Non-consumption is to an extent part of eco-labelling in that certain product groups (e.g. cars) are often excluded from Type I ‘seal-of-approval’ schemes because the product group itself is deemed inherently environmentally damaging.

Information-provision in the form of eco-labelling is used in the deliberation phase to evaluate purchase alternatives and potentially in post purchase review⁴⁷.

The Lancaster-Rosen approach (Lancaster, 1966; Rosen, 1974) provides an analytical economic framework for consumer decision-making. This approach was constructed so as to, “simply carry over traditional preference theory applying it to collections of characteristics instead of to collections of goods” (Lancaster, 1971: 20). Thus, any given commodity within a commodity class can be described by a vector of characteristics. For example, the commodity class might be ‘cars’, for which the characteristics might include: shape and style; engine specifications; reliability; options; safety features; storage capacity; warranty; insurance group *etc.* Environmental and social characteristics that the consumer might consider significant for cars include: fuel consumption; recyclability; airborne pollutants emission levels; pollution from production techniques (e.g. bodywork painting); expected durability (i.e. life cycle). The price at which the unit is sold is then linked with these characteristics that feed into the aggregate demand for the product/service. It is not the commodity itself *per se* but its characteristics that yield utility according to this approach (Lancaster, 1966).

These characteristics or attributes can be grouped into three categories based on the transactions costs that the consumer needs to expend in gaining information (Nelson, 1970). A *search* attribute is one that the consumer can check by sensory evaluation – feeling, touching, smelling and observing. For the example of car purchase, search attributes might include the visual condition, the service history *etc.* An *experience* attribute can only be checked *ex post*, i.e. after the purchase. For instance, a used car might be sold as being reliable but the consumer can only validate or reject this claim after purchase. The search attribute of service history does condition the consumer’s expectations as to the probability of the car being reliable or not but the attribute itself is only experienced/consumed during ownership. The third type of attribute is a *credence* attribute. These are claims that cannot reasonably be validated at all, even after the purchase. For instance, the car manufacturer might claim that the environmental impact of the painting process applied was relatively environmentally benign but the consumer cannot easily validate this.

Under Lancaster-Rosen (and neo-classicism in general), an individual consumer has a well-defined set of preferences. These determine the weighting applied to each attribute. These preferences can be modified through marketing or it can try to appeal to an individual’s tastes, i.e. either a new set of preferences are ‘created’ by marketing or marketing simply appeals to a

⁴⁷ If the environmental attribute remains a credence attribute (which are discussed later in this section) *ex post* then the existence or otherwise of an eco-label is unlikely to form part of the post purchase review.

set of extant preferences. Green consumerism generally falls into the latter category. As mentioned above, some critics of conventional green marketing (e.g. Welford, 1995) suggest it should be a tool for a paradigm shift in consumption, i.e. stimulate a new type of preference formation in consumers: “[‘green’ marketing] is not only about selling, but encompasses wider issues such as environmental education and campaigning for the issues which will help bring about sustainability” (Welford, 1995:154)⁴⁸.

Soler (1996) suggests that environmentally friendly purchasing is shaped by consumers’ experiences⁴⁹. These can propagate an association between environmental issues and the consumer’s own behaviour. Several studies support this contention (e.g. Baldassare and Katz, 1992; Black and Stern, 1985; Borgida and Campbell, 1982; Kok and Siero, 1985; Olsen, 1981). However, this association might not be sufficient unto itself to elicit a change of habit if an individual perceives that his/her personal contributions to, say, ozone depletion is insignificant. This is in keeping with rational economic behaviour: every individual consumer is ‘small’ vis-à-vis his or her direct impact on global environmental problems such as ozone depletion. Any unilateral ‘ethical’ consumption decision is then irrational. (This is the well known free rider problem in the provision of public goods.) However, the assumed individualistic behaviour of ‘*homo economicus*’ (Daly and Cobb, 1989) contravenes the collectivist element to behaviour described in Etzioni’s ‘I&We’ paradigm (Etzioni, 1988) and discussed in Chapter 2. Thus green consumerism might better be explained through the latter models⁵⁰.

Murphy (1989) documents a typology of different shades of ‘greenness’, which might be associated with different levels of balance between the conflicting ‘I’ and ‘We’ of Etzioni (1988). Murphy (1989) classifies UK green consumers into four categories. The widest base category is ‘generally concerned’ which includes everyone who voices some measure of concern for the environment regardless of whether they have acted on this concern or not (80-95% of the total population). A subset of this is the ‘green consumer base’ (45-60% of the total population) that perceive that they have taken some form of action such as purchasing recycled paper. The next population subset in the Murphy hierarchy is ‘green thinkers’ (25-30%) who actively seek out green alternatives and might engage in time-consuming activities such as composting. The final subset (and the top of the hierarchy) is ‘green activists’ (5-15%) who are

⁴⁸ The *reductio ad absurdum* implication of the Welford (1995) proposition is that car manufacturers ought to convince their customers to use public transport instead of buying their products, as the former transport option is generally more sustainable.

⁴⁹ Soler (1996) is not referring to experience attributes as per the Lancaster-Rosen approach, rather experiencing the natural environment first hand through roaming in the countryside *etc.*

⁵⁰ Bjorner *et al.* (2004) suggests that there is a literature *within* the NC tradition on the nature and implications of altruistic preferences. They cite, for instance, Johansson (1997) that develops a framework for optimal Pigovian taxes under altruism and Nyborg (2000) that considers the aggregation of environmental values.

either members of or supporters of environmental organisations.

Aside from the issue of how decisions are made ('I&We' versus '*homo economicus*') there is the question of what consumers are actually doing in practice, i.e. the extent of (and trends in) the market for green commodities. The evidence base here might be divided into stated preference and revealed preference studies. There is a good deal of survey-based evidence in the former category. Simintiras *et al.* (1994) review studies that document the changing perceptions of consumers. The authors find conflicting evidence, citing Herberger and Buchanan (1971) and Kerin and Peterson (1974), both of which find that consumers are reluctant to pay a premium, whereas Henion *et al.* (1980) find the reverse to be the case. This divergence may well be explained by the fact that the environmental movement (and concomitantly green consumerism) had marched along in the years between these studies and clearly has changed since.

More recent stated preference studies appear less equivocal. For instance, Callenbach *et al.* (1993) report that, in a survey of consumer preferences conducted in the US, 25 per cent of respondents claimed that they had changed their spending patterns owing to a negative perception formed of particular firms. In the UK, a survey by a product development consultancy in 1989 revealed that 75% of respondents stated that were willing to buy a product option that was biodegradable and had recyclable packaging and roughly as many were willing to pay a premium for such (Cairncross, 1992). The study reported in Wessells *et al.* (1999) investigates consumers' stated preferences for eco-labelled seafood (cod, cocktail shrimp and salmon) in the US market. The 1640 telephone respondents state an average willingness to pay of between \$2 and \$5 per pound for a certified alternative that respondents were informed would "guarantee that it [the eco-labelled seafood] was caught under strict controls that prevent too much fishing". The certifying agency alternated between the World Wildlife Fund, the National Marine Fisheries Service and the Marine Stewardship Council. The aforementioned premiums applied to like for like comparisons, e.g. certified versus uncertified cod, and all other product attributes were constant across the comparison. However stated preference studies are likely to suffer from a systematic bias in that respondents are likely to inflate their stated willingness to pay for the environmental product attribute owing to their desire to appear 'ethical' in their consumption. I would support the contention of OECD (1997) that most evidence in the stated preference studies is anecdotal.

There is evidence of a green premium from revealed preference studies. Tiesl *et al.* (2002) consider real market time series data for canned seafood and substitute meat products in an investigation into the effect of the 'dolphin safe' label for tuna. However, these data (as

acknowledged by the authors) would include fluctuations arising from market trends that are unrelated to the label and thus *ceteris paribus* conditions are unobtainable since all brands of tuna available for sale were labelled as 'dolphin safe'. Thus the analysis is of a product group as opposed to a particular product brand. Given this caveat, the authors do find there to be a statistically significant effect arising from the label, *viz.* a price premium.

Blamey and Bennett (2001) carry out analyses of two environmental attributes of toilet paper using real market data. They report that a label of 'unbleached' did not have a statistically significant effect whereas 'recycled' did. However the analysis relies on data pertaining to one brand and thus there may have been extraneous factors *vis-à-vis* brand characteristics and popularity. The same criticism might be applied to a much earlier study in this field, Henion (1972). This study found, through the analysis of real market data from four stores, a significant effect on detergent sales arising from the labelling of phosphate content. Nimon and Beghin (1999) carry out a hedonic regression but applied to catalogue prices (in 1996) as opposed to actual sales data. In their analysis of the market for clothing, they find there to be an effect for 'organic cotton' (average premium 33.8%) but did not find a statistically significant effect for the 'environmentally friendly dyes' and 'no- dye' labels.

Perhaps the most pertinent study to this research is the analysis of Bjorner *et al.* (2004). The authors model the effect of a third-party certified ecolabel (the Nordic Swan) on Danish consumers' purchasing of toilet paper, paper towels and detergents between 1997 and 2001. The coefficient SWANN for labelled toilet paper was significant at a 1% level. The authors report that the marginal willingness to pay for Nordic Swan labelled toilet paper was 13-18%, depending on the brand. 13 of the 32 different brands of toilet paper obtained the label in the period analysed. Of these 13, 2 products were launched to market with the Nordic Swan. Thus the dataset that is not brand specific – therein ameliorating the aforementioned methodological issues of brand characteristic variation – and includes *ex ante* and *ex post* data for Nordic Swan accreditation. The results for toilet paper are the strongest of the three product categories. 9 of the 26 brands of paper towels were accredited during the analytical period and 3 of the 15 detergent brands. For toilet paper, the SWANN coefficient is significant at the 10% confidence interval. The results are more equivocal for detergent, but this is in part because the market share of 2 of the 3 labelled detergents was very low.

In summary, there does appear to be reasonably strong evidence of green consumerism both from the limited number of revealed preference studies using market data and (less equivocally) from stated preference studies. It does thus seem that 'environmental quality' as a product attribute is one that a sub-section of the population of consumers values and is willing to pay a

premium for. This finding is of significance to the analysis of firm behaviour that follows in the next section.

Although there is evidence of on-going green consumerism, OECD (1997) reports the findings of a survey carried out by the Federal Environmental Ministry of Germany on trends over time vis-à-vis the German *Blue Angel*. Willingness to pay a price premium fell between 1992 and 1996 from 59% to 35% in West Germany and from 24% to 17% in East Germany (OECD, 1997, p.60). OECD (1997) attributes this decline to consumer confusion and the proliferation of different labels, an issue that I return to below in discussing the strategic behavioural model developed in Section 8.5.

Before turning to the supply side, it is perhaps important to note that consumers are likely to be *inconsistent* vis-à-vis their green behaviour. Thus, one particular purchase by a given consumer might be characterised under the ‘green activist’ subset of the Murphy (1989) typology whereas another purchase by the same consumer may fall under a different subset. For instance, a consumer might simultaneously be a ‘green activist’ with respect to, say, his or her chosen mode of local transport (using public transport or bicycles) whilst choosing long-haul flight destinations for holidays⁵¹.

This inconsistency might occur for several different reasons. First, there may be some discrepancy between perceived versus actual impacts. As I discuss in Section 8.4 below, the ‘environmental impact’ of a product or service is a composite variable. Note further that consumers might also consider the social impacts of consumption such as ‘fair trade’ *etc.* This would add further elements to the composite variable. One alternative in the product category might score well in terms of, say, climate change impacts whilst scoring poorly in terms of ozone depletion potential. Life cycle assessment attempts to weight these impacts and generate a composite environmental score for alternatives within a product category but most purchasing decisions are made without reference to (or the availability of) this scientifically estimation of ‘actual relative environmental impact’. Thus the consumer’s perception of socio-environmental impact may not coincide with the actual impact, therein implying inconsistent purchasing behaviour.

A second potential source of inconsistency is transactions costs. Consumers might be reluctant to expend time/effort in determining the relative greenness of competing alternatives, but might

⁵¹ I assume that the consumer has some discretion in his or her choice of holiday destination, i.e. he or she could *choose* an alternative with a lower environmental impact. If the consumer is *compelled* to travel to a destination for which there is no alternative but air travel then no inconsistency applies.

potentially be part of the 'green thinkers' subset if reliable and trustworthy information is easily accessible. Thus a consumer might pay a premium for a washing machine that has a high EC energy efficiency rating, therein revealing a preference for the environmental attribute, but choose a laptop without reference to its environmental impact. In the former case, there is a near zero transactions cost as energy, noise and performance ratings are mandatory for appliances in the product category marketed within the EC whereas this does not apply in the latter case.

A third issue with respect to inconsistency is cultural norms and values. Whereas unfettered car use might be perceived by a consumer's peer group as being anti-social, holidays entailing long haul flights may not be⁵². Needless to say, cultural norms and values change over time, an issue discussed with reference to road policy in Hillman (2004).

In summary, there is evidence that some subset of consumers is willing to search for and pay a premium for products that have an environmental impact that is low relative to competing products in that product category. The decisions that consumers make are not always consistent. Even if the consumer feels a sense of duty and responsibility, it would be rational and consistent to achieve the biggest net reduction in socio-environmental impact for a given financial expenditure and/or for a given transaction cost. Some of the causes of this inconsistent behaviour might be addressed were trustworthy information on socio-environmental impacts to be made available and this is the rationale behind eco-labelling.

Soler (1996) proposes that instructive and trustworthy information is a factor in that it allows rational decisions to be made by consumers based on their intentions, regardless of the consumer's level of greenness. This proposition is of key significance to the argument of the strategic behavioural model developed in Section 8.5. Burnside (1990) reports on a face-to-face survey of 1200 UK consumers that found that 56% of respondents were suspicious of 'environmentally friendly' claims. Evidence of grounds for such suspicion is discussed with reference to firm behaviour in the section that follows.

8.3 Firms and eco-labelling

On the supply side, claims by a manufacturer that a product is 'environmentally friendly' do not imply that the production, distribution, consumption and disposal of that product have no

⁵² Carbon Neutral Newcastle report that, in a survey of 1000 respondents, three-quarters state a concern about climate change. However, just over one-third of respondents were not willing to take public transport and a huge 80% would not consider reducing their holiday flights. (<http://www.carbonneutralnewcastle.com/campaigns/viewarticle.php?category=Public%20Attitudes>, last accessed 12.10.2008)

harmful environmental impacts, only that these impacts are low relative to competing products in the same category. One aspect of green consumerism is the outright rejection of a category of product owing to the perceived environmental and/or social impact of all products in that category in absolute terms. There is no incentive for the firm to promote a green image to this subset of consumers as no purchasing results from this (costly) promotion. However, this subset is likely to be small vis-à-vis the total population of consumers in virtually all conceivable cases. There is potentially an incentive to promote products as green if some subset of consumers does both respond to green marketing and still purchase at least one of the competing products in the category. This is likely to apply to the majority of product categories, but this subset of green consumers is likely to vary across categories. Thus there is, in many cases, a profit-related incentive for firms to convince consumers that their product has a relatively low socio-environmental impact.

There can then be an incentive for self-interested, profit-maximising firms to make false green marketing claims, i.e. 'greenwashing'. There is evidence of greenwashing documented in Simintiras *et al.* (1994). Firms which have been criticised for greenwashing include: BP Supergreen petrol which was shown to contain several toxic chemicals despite its pollution-free tag (Peattie, 1990); ICI for producing the ecologically-hazardous pesticide Aldrin and Dieldrin (Corrigan, 1989); and ICI (India) for their marketing of an ozone-depleting chemical in developing countries whilst proclaiming their corporate greenness (Friends of the Earth, 1991). In the early 1990s, Iyer and Banerjee (1993) found that nearly one-third of all green advertising claims were no more than vague statements (e.g. brand X is 'environmentally friendly'). Although not greenwashing *per se*, the very vagueness of these claims implies that they were unsubstantiated. The reason that such greenwashing can occur is because of the fact that the environmental performance of a product or firm is a credence attribute and there is asymmetric and imperfect information, i.e. the firm has more reliable information than the consumer but this information on green performance may be wrong.

I discuss the Murphy (1989) typology for consumers above. A similar typology might be applied to the firm vis-à-vis greenwashing. This typology follows that of Hussain and Moran (2005) that investigates firm behaviour with respect to food safety provision. The population of firms might be split into three broad subsets: F_{CSR} , F_{LAW} and F_{CHEAT} . F_{CSR} is the subset of firms that apply the principles of corporate social responsibility. A firm in this subset would never knowingly greenwash (but might unwittingly do so). Further, firms in F_{CSR} might voluntarily choose to adopt production processes that improve their socio-environmental performance but reduce profitability ('win-lose') through a sense of duty and responsibility. F_{LAW} represents the subset of firms that are profit-maximising but never knowingly contravenes regulation. Such

firms would engage in green marketing within the confines of the law but would instigate voluntary changes that reduce socio-environmental impacts if and only if a ‘win-win’ outcome was anticipated. Note that the scope of what is deemed legally permissible may be quite wide. Firms that populate the F_{CHEAT} send a marketing message to green consumers if it is profitable to do so. If expected profitability increases through sending such a message then the F_{CHEAT} firm does so regardless of whether the message is valid or is simply greenwashing. The difference between F_{LAW} and F_{CHEAT} is that the former sends a signal if and only if the signal is both legally defensible and increases expected profitability, whereas increased expected profitability alone is a sufficient condition for F_{CHEAT} .

The legality of the message and expected profitability are themselves inter-related. The expected net profitability of sending a green marketing message depends on the firm’s estimation of various costs and benefits. The firm’s estimation of private benefit depends on expected changes in both the consumer base (volume of sales) and the price and profitability per unit sold. The consumer base may be wider if it includes green consumers *ex post*. There may also be a price premium paid. Both of these factors affect expected private benefit.

Note that a rational profit-maximising firm would take into account discounting. The distinction between the expected discounted stream of benefits and nominal benefits may be important for the following reason: if F_{CHEAT} sends a greenwashing signal and is only caught (and punished with the imposition of various private costs, discussed below) some time in the future then the higher the discount rate, the lower the value of the expected future penalty to the firm in present value terms. Thus, in determining its optimal strategy vis-à-vis green signalling, F_{CHEAT} makes some prior estimation of not only the likelihood and severity of penalties being applied but also when the associated costs would be likely to occur.

The private cost to the firm (the penalties) has various elements. First, there is the cost of sending the signal itself, i.e. marketing costs. Second, there are those costs that might arise from changes in the production process to reduce socio-environmental impact. Note that F_{CHEAT} may not incur any such costs if sending a signal that is greenwashing⁵³. The third element of cost is the expected costs associated with being ‘caught’ sending a signal which either *is* greenwashing or *is deemed to be*. Although there is certainly some degree of uncertainty about these first two cost elements, the uncertainty associated with the third element is much higher.

⁵³ It is possible that the other subsets of the population of firms also might not incur such costs. This may occur for two reasons. First, the product itself may *already* have a socio-environmental impact that is genuinely lower than competing products in its class. Second, there may be ‘win-win’ outcomes, implying zero (or negative) net costs from improving socio-environmental impact.

There are two sub-categories of this third cost element: penalties imposed by public/regulatory bodies and penalties in terms of shifts in consumer choice. Whereas the former should only apply in cases where the signal is legally proven to be greenwashing, the latter could apply if the firm's actions are deemed to be irresponsible. This latter case can apply regardless of whether the firm is F_{CSR} , F_{LAW} or F_{CHEAT} . These penalties might take the form of shifts in consumer choice away from the product and/or the firm deemed to be greenwashing. These shifts might be short run or longer run in nature.

In summary, there can be incentives for a firm to send a false or misleading message concerning the socio-environmental impacts of its products and processes. I have characterised the population of firms as being comprised of three subsets: F_{CSR} , F_{LAW} or F_{CHEAT} . The product attribute of socio-environmental impact is a credence attribute and as such consumers must decide whether or not to believe messages sent by firms. There is a potential market failure arising from the fact that there can be asymmetric and incomplete information vis-à-vis this credence attribute. The conditions under which such a market failure might occur are set out in the strategic behavioural model developed in Section 8.5. One potential approach to ameliorating the potential for adverse selection is through participation in eco-labelling schemes that are verified by a third party. Such schemes are the subject of the next section.

8.4 The designation of eco-labelling schemes

There are three broad categories of eco-labelling schemes: these are drawn out and compared in Section 8.4.1. The focus of this research is Type I accredited schemes. The issues pertaining to such schemes are discussed in Section 8.4.2 and the development of competing Type 1 schemes is discussed in Section 8.4.3.

8.4.1 Different types of eco-labelling schemes

Environmental labelling might be subdivided in various ways, one of which is to consider mandatory versus voluntary labelling (Kuhre, 1997). The former provides users with warnings and caution concerning the handling and treatment of the labelled substances such as radioactive waste and regulated hazardous materials. This research focuses on the type of eco-labelling which is currently voluntary, i.e. the green marketing tool. The US Environmental Protection Agency (EPA, 1993) consider such schemes, which are also termed environmental certification programmes, to be potentially significant in terms of achieving environmental policy goals. Voluntary environmental labelling is sub-divided into three types: Type I general environmental labels; Type II environmental self-declaration; Type III certified scientific

information⁵⁴. Table 20 provides a synopsis of the different types of eco-labelling schemes.

Table 20 Types of environmental labels

	TYPE I	TYPE II	TYPE III
	<i>Environmental labels</i>	<i>Self-declaration of environmental claims</i>	<i>Quantified product information labels</i>
Characteristics	Independent certification	Self-declaration	Independent certification or self-declaration
Product-category	Selected categories	All categories	All categories
Methods	LCA, LCC or Scientific Data	Scientific Data/qualitative assessment	LCA, LCM
Validation body	Independent	Firm itself or otherwise	Firm itself or otherwise

(adapted from Hussain and Lim, 2000)

A Type I environmental label refers to general voluntary eco-labelling schemes with external accreditation. There are two principal categories of Type I labels: ‘seal-of-approval’ and ‘single attribute’ certification. ‘Seal-of-approval’ schemes categorise the product and/or service as having an environmental impact that does not exceed some benchmark level. A common methodology is applied: product categories (e.g. ‘solvents’) are selected; criteria are set based on environmental impacts through the application of life cycle assessment and/or life cycle consideration (LCC) and/or life cycle management⁵⁵; the labels are awarded to products and/or services that satisfy the criteria. Under ‘single attribute’ certification, the consumer is left to decide whether accreditation implies improved overall environmental performance.

‘Type II’ voluntary eco-labelling is the self-declaration of environmental claims without independent external verification. These claims might be made by a first party (the producer, retailer or distributor) or by third party industry bodies. Although these third parties are not necessarily directly linked to the firm applying the eco-label, they are also not entirely independent bodies. Type II eco-labels are applied to suggest the environmental superiority of the products and/or services based on such environmental issues as the extent to which the product is designed for disassembly and/or recycling, energy use *etc.* Since the institution

⁵⁴ The International Organisation for Standardisation (ISO) has categorised these three types respectively under ISO 14024 (1999), ISO 14021 (1999) and ISO 14025 (2000).

⁵⁵ Life cycle *assessment* differs from *consideration* in that the cradle-to-grave analysis in the former is purely quantitative whereas in the latter it is both quantitative and qualitative (Fox and Singh, 1997). Life cycle management integrates occupational safety with environmental issues, and in particular recycling, as part of the overall management decision-making or government policy-making process (*ibid.*).

making the claim determines which aspect(s) of environmental performance it reports on, it can select those aspect(s) which put its product and/or service in a favourable light.

A distinction might be made between first and third-party Type II claims. The latter are perhaps somewhat less open to greenwashing and are, to a limited extent, externally accredited by an industry association. However, to some degree the proximity of interests for the judge, jury and defendant in these cases might lead to less than ideal due process and administration of such schemes. Thus an economic case might be made for monitoring of such self-declarations by government authority and/or consumer organisations to protect consumers from greenwashing infringements.

‘Type III’ voluntary eco-labels are quantified product information labels: this is a relatively new development in eco-labelling. Generally, this is likely to be the results of life cycle analysis. For instance, Volvo was responsible for publishing *Environmental Product Declaration: Volvo S80 2.9* (Volvo, 1998). This includes quantitative and qualitative environmental information about the car sub-divided into four principal areas of environmental performance: manufacturing; operation; recycling; and environmental management. This type of eco-label differs from Types I and II in that the information disclosed might be negative as opposed to only neutral or positive. However, Type III is similar to Type II in that the firm decides which impacts to examine/declare and the results need not necessarily be verified by a third party.

8.4.2 Issues pertaining to Type I eco-labels

The last two decades have seen a rapid expansion in national and international Type 1 eco-labels. This has been in part a response to the conflict between other environmental policy instruments and World Trade Organisation (WTO) principles of non-discrimination. Since differential tariffs cannot be placed on ‘like products’ defined with regards their end use, WTO members cannot impose tariffs on commodities produced in an environmentally harmful manner (Robertson, 2003). GATT Article XX (WTO, 1998) does permit trade sanctions to protect animal life and exhaustible resources, but Appleton (1999) suggests that the compliance conditions required are so restrictive as to render the Article redundant. Robertson (2003) suggests that Type 1 eco-labels then might act as an international environmental policy tool, as is perhaps the case for the US ‘dolphin-friendly tuna’ market.

The United Nations (UNEP, 1991) sets out guidelines for the efficient operation of Type 1 schemes: a legally protected logo or symbol for the scheme; governmental endorsement; operated by institutions (including government) which do not have a commercial interest in the

awards; and periodic review of the process, categories and criteria. The designation of product categories open to Type I schemes is a contentious issue. Accreditation sends a signal of eco-endorsement to consumers. Consider automobile eco-validation: there is a trade-off associated with the inclusion/exclusion of cars as an eco-label product category. Environmental lobbyists propose that more ecologically-benign transport options, such as integrated public transport and cycling, should be promoted through awareness-raising campaigns informing car-using consumers of the negative externalities arising from their transport decisions. Eco-labelling for cars then undermines such campaigning. On the other hand, there may be a significant sub-set of car-using consumers for whom car use is the only viable transport option (and indeed possibly the most ecologically-benign option⁵⁶) and who are environmentally-conscious. For this subset of consumers, an externally accredited eco-labelling scheme would allow them to signal their preference in the market for a greener car without having to rely on Type II and Type III self-endorsement schemes operated by car manufacturers or their industry bodies.

Another contentious debate in eco-labelling surrounds *how* to set the bar and *how high* to set the bar. The answer to the ‘how’ question can be divided into ‘pass/fail’ versus ‘scoring’ systems. This division occurs at two distinct levels: first, what the green consumer sees on the label; second, the methodology for achieving the label. In a voluntary Type I scheme, a minimum threshold level of performance will need to be set and met by all the scheme’s participants. If the only information provided to green consumers is that their proposed purchase is either labelled or not then this is a form of pass/fail system. If the product achieves the eco-label at one of several grades/levels then some form of scoring system is required. A scheme’s operatives might decide that an application must pass some critical threshold level of performance for all of these aspects. The alternative is to apply a scoring system whereby an applicant can score poorly in some aspects but be successful overall by compensating sufficiently for these failings in other aspects. In essence, LCA is a methodology that provides a systematic means of applying this scoring/weighting.

With regards the ‘how high’ question, the scheme’s organisers must make a trade-off: the momentum generated by widespread approval/application of the scheme versus the discrimination allowed by tighter screening. If all products (or the vast majority of products) in a category meet the scheme’s criteria then green consumerism is stifled. Schemes generally apply a time period limitation on the right to apply the label. This allows the scheme’s

⁵⁶ The number of passengers per bus/train/tram must exceed a critical threshold in order for this public transport option to have a lower ecological impact than car use; this threshold might not be reached in some journeys, especially (but not exclusively) for travel in remote areas.

operatives to revise the standards and criteria in place in light of either the level of uptake and/or based on technological developments in the given industry.

How the certification body decides to administer and operate the scheme affects the ability of the scheme to stimulate green consumerism. A potential negative externality applies on an intra-scheme level. If the 'how high' question is answered in a variety of ways across schemes then there may be a tendency for the firm to select schemes that have a low critical performance threshold to the detriment of other, more stringent schemes. (A scheme's success depends partly on its visibility and the consumer's awareness: it thus needs a critical mass of certified products. It is less likely to achieve this critical mass if firms select other schemes owing to their less onerous assessment procedures.)

The questions of 'how' and 'how high' pertain to individual schemes. A final issue is 'how many'? As mentioned above, OECD (1997) postulate that the reduced willingness to pay a price premium for the German *Blue Angel* scheme arises from confusion and the proliferation of schemes implying that too many competing schemes exist.

Robertson (2004) implies that some consumers have negative reaction functions, i.e. they substitute away from the environmental attribute as a response to others shifting their preferences towards greener options. The author does state that:

[there] is no suggestion, however, that an equilibrium would actually be observed, or that institutions exist to allow consumer behaviour to dynamically adjust toward this equilibrium. This result therefore, should not be taken as a literal description of potential outcomes, but simply a point of reference for thinking about the incentives created by eco-labelling policies (Robertson, 2004: 17)

I find the jump from this stated limitation to the assertion by the author that some of the shift away from *Blue Angel* price premiums might be explained by free riding somewhat arbitrary. Robertson (2004) is one of a select number of theoretical papers that, through theoretical modelling (as opposed to empirical analysis) highlight potential perverse outcomes that might arise in eco-labelling. Another such potential perverse outcome is analysed in Dosi and Moretto (1998). The authors assume that eco-labelling stimulates environmental innovation and reduces the supply of conventional (relatively highly polluting) products. They develop a model that has a rather intuitive outcome, but one that should be borne in my vis-à-vis the analysis of social optimality in scheme designation. If the eco-label is conferred on a product *in isolation* but this eco-label affects consumers' perceptions of the greenness of the firm *in general* then aggregate environmental impact may increase if, owing to this change in perceptions, consumers switch

demand to other non-green products from that same firm. In a similar vein Bougherara *et al.* (2005) develop a model wherein aggregate environmental impact rises owing to what they term environmental elasticity of demand: given an assumed fixed budgetary spend in a product sector, consumers might switch to a cheaper alternative once it is eco-labelled therein substituting their spending away from a competing product that has a lower environmental impact but is more expensive; the net outcome is higher environmental impact arising from the eco-label. The design and implementation of eco-labels can thus influence its efficacy. The development of international eco-labelling schemes is the subject of the next section.

8.4.3 The development of Type I eco-labelling schemes

There are approximately 30 major eco-label schemes extant in the world; a synopsis of some of the features of the major eco-labelling schemes is given in Table 21 (Hussain and Lim, 2000). The German *Blue Angel* was the first environmental certification programme to be set up, starting in 1977. At inception, the criteria for participation in this scheme were single attribute ones such as recyclability *etc.* but the current *modus operandi* is the one common to such schemes, i.e. multi-issue evaluation based on the LCA methodology or similar (Life Cycle Consideration).

The European Union's Eco-labelling scheme was established in 1992 based on Council Regulation (EEC) No. 880/92⁵⁷. It was designed in line with the principles, goals and priorities selected by the Fifth Community Environmental Action Programme as well as with Agenda 21. Each member country operates its own schemes based on the guidelines and criteria that are agreed at Commission level. The criteria are determined by both quantitative and qualitative research using life cycle methodologies in feasibility studies and market structure analyses. The rate of scheme uptake has been relatively low owing to the stringency of the criteria set and the competition with extant schemes.

The White Swan scheme was introduced by the Nordic Council in 1989 and has been operated by the Nordic Eco-labelling Board with Sweden, Norway, Finland, Iceland and Denmark as applicants⁵⁸. The protocol and methodologies applied by the White Swan scheme were influential in the development of the EU's Eco-label. Initially, the aim of the scheme was to prevent consumer confusion arising from the co-existence in the Nordic countries of several different schemes. However, the scheme's remit was subsequently extended to consider the development of sustainability through the ecology/industry interface; social criteria have thus augmented the extant environmental criteria.

⁵⁷ http://ec.europa.eu/environment/ecolabel/index_en.htm, last accessed 22.06.2008

⁵⁸ <http://www.svanen.nu/Default.aspx?tabName=aboutus&menuItemID=7069>, last accessed 22.06.2008

Table 21 Characteristics of major environmental certification programmes

<i>Name of Scheme</i>	Blue Angel	EC Eco-Label	White Swan	ECP	Green Seal	Eco-Mark	Environmental Mark
<i>Country</i>	Germany	EU	Nordic Council	Canada	USA	Japan	Korea
<i>Operational Organisation</i>	BMU, UBA, RAL	EU nations	Nordic Council	Terra Choice	Green Seal	JEA	MOE KELA
<i>Established</i>	1977	1992	1989	1988	1989	1989	1992
<i>Product Categories</i>	70	12	43	90	37	69	29
<i>No. of Awarded Products</i>	920	About 200	n.a.	n.a.	18	About 1300	145
<i>Methods</i>	LCA	LCA	LCA	LCA& LCC	LCC	LCC	LCA& LCC
<i>Level of selectivity</i>	20-30%	5-30%	20-30%	20%	15-20%	50-70%	10-20%

(adapted from Hussain and Lim, 2000)

BMU	German Federal Ministry for the Environment
ECP	Environmental Choice Program
JEA	Japan Environmental Association
KELA	Korea Environmental Labelling Association
LCA	Life Cycle Assessment
LCC	Life Cycle Consideration
MOE	Ministry of Environment
RAL	German Institute for Quality Assurance and Labelling
UBA	Germany's Federal Environmental Agency

Outside Europe, the most prominent and established environmental certification schemes are Canada's 'Environmental Choice Program', Japan's 'Eco-Mark' and the South Korean 'Environmental Mark', as summarised in Table 21. What is clear from the above synopsis of the features of some of the international Type 1 schemes is that there is certainly scope for the consumer confusion. One potential means of addressing some of this confusion vis-à-vis the co-existence of many competing schemes is to increase harmonisation across schemes and to allow mutual recognition. Jacobsson and Jonsson (1998) carry out a study of five product groups across twelve Type 1 eco-labelling schemes⁵⁹. The summary of this feasibility analysis is instructive:

⁵⁹ The five product groups are batteries, textiles, laundry detergents, paper and washing machines. The following schemes are included in the study: Austrian *Umwelzeichen*; Canadian *Environmental Choice*; EC Eco-label; German *Blue Angel*; Dutch *Milieukeur*; Indian *Eco-Mark*; Nordic *White Swan*; Singaporean *Green Label*; Swedish *Good Environmental Choice*; Taiwanese *Green Mark*; Thai *Green Label*; US *Green Seal*.

The criteria of the various eco-labelling schemes tend to differ substantially in terms of scope, means of presentation, choice of parameters, test methods, product group definitions, etc., as to render comparisons difficult or even impossible. (Jacobsson and Jonsson, 1998:3)

Thus there seems to be evidence that harmonisation of extant schemes would be difficult to implement in practice. What this implies is the co-existence of competing schemes in the same product category. This unto itself is problematic in that consumers are unlikely to be able to discriminate across competing schemes vis-à-vis the stringency of the criteria applied. However I would argue that such potential for confusion is less consequential than the co-existence of externally-authenticated Type 1 eco-labels and self-certified statements concerning the socio-environmental attributes of a firm's products/processes. The fact that these various forms of marketing each seeking green consumers co-exist is a potential market failure. This is explored in the next section that develops a game theoretical model of behaviour across firm types.

8.5 A strategic behavioural model of 'green' marketing

This section is adapted from Hussain (2000). It contains the description, resolution, limitations and applicability of a novel strategic behavioural model of green consumerism. In brief, the resolution of the model is that, under the conditions of asymmetric information that are likely to exist in the market for green products, and applying the standard economic assumption that firms strive to maximise profits and consumers to maximise utility, the *status quo* vis-à-vis eco-labelling may be economically inefficient. This inefficiency arises owing to the fact that consumers cannot perfectly discriminate between genuine and false/misleading green marketing. Under conditions where it is more costly for a firm to be genuinely green compared with the cost of greenwashing, there is a theoretical possibility of a positive (self-reinforcing) feedback loop coming into play and a market failure can then occur. The form that this potential market failure takes is that, owing to information asymmetry, less and less genuinely green products are manufactured and marketed as such. Under this scenario, green consumerism might be potentially stifled.

The model developed here is founded upon the seminal work of Spence (1973) who modelled job market signalling. My model differs from Spence (1973) in that it is not a 'cheap talk' game: any message sent is not costless. It follows Potters and van Winden (1992, 1996) who considered public lobbying under conditions of asymmetric information. It is a reapplication of the work of Potters and van Winden to a different scenario: firms can choose to signal that their products are environmentally-friendly, in a game where the recipient of the signal (the green consumer) has perfect but incomplete information. The model description and model resolution

are set out in Sections 8.5.1 and 8.5.2 respectively. This is followed by a discussion of the model's empirical applicability in Section 8.5.3. The implications of the model vis-à-vis socially optimal regulatory intervention are set out in Section 8.5.4.

8.5.1 Model description

There are two players, a firm F and a consumer C . C has to take an action g from a set of feasible actions G . g represents the purchase of some differentiated good from a given good category. The payoffs for F are dependent on g and the realisation of a stochastic state variable which takes the value $\phi \in \Phi$, where Φ is a finite set. ϕ is the environmental impact of g .

This model treats this variable as exogenously-determined. The justification for this simplifying assumption is that ϕ is dependent upon both management and operational systems and the plant and process capital *in situ*; the latter is likely to be fixed in the short term. To take an example, for farming local hydrological and atmospheric conditions are likely to be significant in terms of determining ϕ ; these are predominantly beyond the farmer's control although farming practices can be modified so as to minimise impacts *given* these conditions.

The realisation of ϕ is assumed to be private information to F and ϕ is known with certainty by F . The 'true' value of ϕ is not revealed to C until after the choice has been made. F only produces one good, g_1 . Before C takes the action g , F has the option of sending a message m in the form of a marketing campaign. m is selected from the set of feasible messages M : $m \in M$. The cost to F of any message sent [denoted as $c(m)$, where $c(m) > 0$] is fixed and exogenously determined, and independent of both the content of the message and of the realisation of ϕ . What this implies is that, in this model, the cost of the marketing campaign does not vary, and does not depend on whether the environmental loading associated with the firm's good is actually relatively high or low. Sending no message (denoted by n) is costless [$c(n)=0$]. A key element of this basic model is that C can not check the legitimacy of F 's message *ex ante*.

It is assumed that G and Φ each only contain two elements: $G=\{g_1, g_2\}$; $\Phi=\{\phi_H, \phi_L\}$. This need not be a restrictive assumption. g_2 might represent any competing good produced by one of many competing firms. Thus C has a dichotomous choice: purchase of g_1 (produced by F) or the purchase of a competing product g_2 . If the production process for g_1 has an associated environmental loading which is high then ϕ_H applies, and ϕ_L applies if it is low. It is common knowledge that C assigns a prior probability p that the state variable is ϕ_L , and prior probability $(1-p)$ that it is ϕ_H . This implies that the consumer believes that some proportion (p) of goods in the given category is produced with a low associated environmental loading and the rest $(1-p)$

with a high loading. This belief need not necessarily be equivalent to the true proportions. F is sometimes referred below to as F_H or F_L depending on the realisation of ϕ_H and ϕ_L , respectively. There are four state-action pairs associated with ϕ and the dichotomous choice g . The payoffs for the four pairs for C and F respectively are given in Table 22.

Table 22 State-action pairs for the strategic behavioural model

C, F	ϕ_H	ϕ_L
g_1	$[0, b_H]$	$[a_L, b_L]$
g_2	$[a_H, 0]$	$[0, 0]$

It is assumed that $a_i > 0$, i.e. the payoff to C is strictly positive if C chooses g_1 given ϕ_L , or if C chooses g_2 given ϕ_H . The payoffs for C depend upon both g and ϕ . If ϕ_L applies then g_1 is strictly preferred to g_2 by C . This reflects the assumption that C 's utility is higher *ceteris paribus* if C (correctly) chooses a green alternative. The corollary is also true: if the state is ϕ_H then g_2 is strictly preferred to g_1 by C . If the competing good (g_2) is chosen then the payoff to F is always 0. b_L represents the payoff to F_L , given g_1 , and b_H represents the payoff to F_H , given g_1 : the discussion below considers the sign and relative magnitude of variables b_L and b_H .

The model might be interpreted as applicable to the following scenario although this is not the only feasible application. There are many differentiated goods (g_2) currently in a given market *ex ante*, none of which claim green credentials. There is a potential new entrant (F) producing a good (g_1) that could be marketed as a green alternative. Some discrete subset (C) of all consumers in that market attributes a positive and significant value to the good's environmental characteristics. If members of this subset find out *ex post* that the new entrant is green then their utility is higher if they had switched consumption to it *ex ante* as compared to the scenario where they stick with their original choice g_2 *ex ante*. However, the reverse also applies, i.e. disutility *ex post* if they have switched *ex ante* and they find that ϕ_H applies. If ϕ_H applies then C 's environment is significantly degraded *ex post*, whereas if ϕ_L applies then it is not.

This scenario is limited to an environmental impact which C can directly attribute to the behaviour of F and F alone. If this condition does not apply then C cannot determine with certainty whether F is type F_L or F_H *ex post*; this would imply that C 's anterior and posterior

beliefs are identical. Thus, this model is not applicable to, say, green marketing vis-à-vis global warming, or indeed to any environmental attribute that remains a credence attribute.

A scenario that is feasible under the conditions of the model (henceforth ‘Scenario 1’) is the eutrophication of a local water course caused by the discharge of slurry by one isolated farming enterprise, the effects of which are determinable through sensory evaluation, e.g. improved appearance and/or reduction in offensive odours. Another potential feasible scenario could be claims by a farming enterprise of reduced pesticide-use in order to protect endangered bird populations; the reliability and validity of such claims might be testable *ex post* but not *ex ante*. Further discussion of the model’s applicability is presented below in Section 8.5.3.

8.5.2 Resolving the Model

The next stage is to resolve the strategic game, adapting from Potters and van Winden (1992). Let $\theta(m)$ denote C ’s strategy, defined as the probability that C chooses g_1 after being sent a message $m \in M$ by F . Let $q(m)$ define C ’s posterior belief, defined as the subjective probability that $\phi = \phi_L$ after receiving a message $m \in M$. Let $\sigma_i(m)$, $i=L,H$ denote F ’s strategy, defined as the probability that F sends a message $m \in M$ when its private information concerning the state variable is $\phi = \phi_i$. An equilibrium is defined by strategies (θ, σ) given the following 3 conditions:

- 1) if for some $m \in M$, $\sigma_i(m) > 0$ then m maximises $b_i \theta(m) - c(m)$; in addition $\sum \sigma_i(m) = 1$ for $i = L, H$;
- 2) if $\theta(m) > 0$ (< 1) for some $m \in M$ then $q(m) \geq$ (\leq) $\alpha = [a_H / (a_H + a_L)]$;
- 3) $q(m) = \text{Prob} \{ \phi = \phi_L \mid m \} = p \sigma_L(m) / [(1-p) \sigma_H(m) + p \sigma_L(m)]$ if the denominator is positive; if not, the belief $q(m)$ must be ^{concentrated} on the F type that is ‘most likely’ to send the off-equilibrium message m .

Condition 1 states that, if it is strategically viable that F sends some message (i.e. there is some expected net private benefit), then any message chosen should maximise the expected payoff of F given the strategy of C . This condition applies to the entire set of F types, i.e. F_L and F_H . What is assumed therefore is corporate social responsiveness as opposed to corporate social responsibility *per se*. Further, this model is a simplification of real-world environmental signalling in that the ‘message’ is assumed to be of one unique type – the model does not characterise different types of messages/marketing but is concerned with the credibility and reliability of any (homogeneous) message sent.

Condition 2 states that if the probability of C choosing g_1 is positive given some feasible message from F , then C 's posterior probability that $\phi=\phi_L$ must be greater than α . For exposition, consider a simple numerical example: let $a_H = 5$ (i.e. 5 is the payoff if both g_2 and ϕ_H apply), and $a_L = 15$ (i.e. 15 is the payoff if both g_1 and ϕ_L apply). This implies that $\alpha=0.25$. If C 's posterior probability $q(m)$ that $\phi=\phi_L$ is say 0.2 (i.e. less than 0.25), then the expected payoff from g_2 ($5*0.8=4$) exceeds the expected payoff from g_1 ($15*0.2=3$). In this case (i.e. one where the posterior probability is strictly less than α) g_1 is not selected. Thus, if the probability that C chooses g_1 is strictly positive, $q(m)\geq\alpha$ must apply.

Condition 3 technically states that Bayes Law must apply where possible, and in other cases C 's beliefs must be that the F -type that has the least disincentive to send m did so. Bayes Rule states that the conditional probability of event A occurring, given that event B has occurred, equals the probability that both A and B will occur, divided by the probability that B will occur (Gibbons, 1992).

Three distinct outcomes can arise, each of which is treated in turn below:

- a) There is an absolute conflict of interest if $b_L < 0 < b_H$: C prefers g_2 given ϕ_H , and g_1 given ϕ_L , whereas F prefers g_2 given ϕ_L , and g_1 given ϕ_H , i.e. the antithesis. F would like C to believe that the state is ϕ_L if the realised state is ϕ_H , and would also like C to believe that the state is ϕ_H if the realised state is ϕ_L . Owing to rational expectations, C 's *ex post* response to any message is going to be unfavourable to F , and thus no message is sent *ex ante*.
- b) There is no conflict of interest between C and F if $b_H < 0 < b_L$. Under this outcome, both agents prefer g_2 given ϕ_H , and g_1 given ϕ_L . There is no incentive for F to send a misleading message regardless of its type and thus C need never mistrust any message sent.
- c) There is a partial conflict of interests if $b_L, b_H > 0$ ⁶⁰. In this case, both F -types have an incentive to make C believe that the state is ϕ_L as this would imply C choosing g_1 , with payoffs to F of b_H and b_L for ϕ_H and ϕ_L respectively, as opposed to the alternative payoff of 0 in either case given g_2 . So F_H has an incentive to misinform about ϕ , and F_L an incentive to tell the truth.

⁶⁰ There is also a partial conflict if $\underline{b}_L, \underline{b}_H < 0$, but this case is not treated further as F 's objective would then be to minimise losses rather than maximise positive payoffs. Since the model is concerned with voluntary signalling, this outcome is not explored further here.

Outcome (a) is counter-intuitive in relation to this green marketing model. For (a) to apply, F prefers C to choose a competing good (g_2) if and only if the environmental loading from its good (g_1) is low. Under (a), any marketing campaign is *always* misleading and C is perfectly aware of this: there is then no scope for green marketing. Note however that this depends on the assumption that both C and F make decisions under conditions of perfect information, i.e. both parties know the respective payoffs to both agents with certainty. If this condition does not apply then there can be scope for green marketing and indeed for greenwashing.

By contrast, outcome (b) contains the condition for perfect information transfer through green marketing. Only green goods are marketed as green: there is no greenwashing. This information is instructive and trustworthy, allowing rational decisions to be made by consumers based on their intentions, a criterion that Soler (1996) considers critical for the efficient operation of green consumerism, as discussed above.

Outcome (b) appears socially desirable, but how can it be obtained? The critical condition is: $\underline{b}_H < 0 < \underline{b}_L$. With regards $0 < \underline{b}_L$, it appears entirely empirically reasonable to assume that the payoff to F_L is positive, given both C 's purchase of its product (g_1) and ϕ_L . This is the essence of green consumerism – that there is a niche market in which green firms can operate profitably. However, $\underline{b}_H < 0$ implies a negative payoff to F given C 's choice of a F 's good (g_1). If the payoff to F_H is negative even if C chooses its product then there is no incentive for F_H to enter the market *ex ante*. The implication is that the market for green alternatives functions with only 'true' green marketing. Well-functioning eco-labelling schemes might attain outcome (b), or something approximating to it⁶¹.

The rest of this section concentrates exclusively upon outcome (c), which requires further theoretical analysis. Potters and van Winden (1992) state certain propositions with regards the feasibility of this outcome. The pertinent ones are expressed and reinterpreted for this green signalling model. The first set of propositions (I and II) are necessary for the application of the signalling game:

- I. $b_L > c(m)$. This intuitive condition states that, in order for any green marketing campaign to be instigated, the payoffs to F_L must exceed the costs.

⁶¹ I use the term 'approximating to' as greenwashing can never be eradicated from the market. The designation of what exactly 'environmentally-friendly' production is for a given product sector is complex. Thus even if all corporate environmental claims are pre-screened, this 'grey area' with respect to designation is bound to allow some greenwashing to persist.

II. $b_L > b_H$. The payoff to F_L from C choosing g_1 must exceed the associated payoff to F_H . This condition is necessary to ensure that the incentive for the ‘right’ F -type to send a message should exceed that of the ‘wrong’ type. From C ’s viewpoint then, F ’s stake in persuading C that ϕ_L applies is larger when F ’s private information is of the kind that justifies a message. If this condition does not apply then the rational expectations behaviour of C is to assume that F_H sent the message and therefore pick g_2 , since F_H gains more than F_L from doing so. This is antithetical to the desired outcome for both F_H and F_L , and so no message is sent *ex ante*.

It is noteworthy that proposition I only refers to the payoff to F_L , given the (g_1, ϕ_L) state-action pair, exceed the cost of the message. The second set of propositions (III and IV) apply to type F_H , considering $b_H < c(m)$ and $b_H > c(m)$ respectively. Both apply to the scenario where the expected payoff to C , given C ’s prior beliefs, associated with choice g_2 exceeds that of g_1 , i.e. $p < \alpha = a_H / (a_H + a_L)$:

III. If $b_H < c(m)$, then the cost of F_H sending a message is prohibitive. This means that only F_L sends a message, in which case $\phi = \phi_L$ can be assumed by C .

IV. If $b_H > c(m)$, then F_H plays a ‘mixed strategy’. A mixed strategy arises from one player’s uncertainty about what the other player(s) will do. A player’s mixed strategy is a probability distribution over (some or all of) his pure strategies, where a pure strategy is one of the different alternative feasible actions (Gibbons, 1992). If $b_H > c(m)$ applies, then it is the interests of F_H to sometimes send a message. Receiving a message is informative to C , but not conclusive in that both σ_1 and σ_2 are positive. The optimal strategic response of C , given that F_H is playing a mixed strategy, is to also play a mixed strategy, i.e. choosing g_1 some of the time and the other times g_2 .

There is an alternative equilibrium associated with C ’s prior beliefs being concentrated on the F_L type, i.e. $p > \alpha$. Under Scenario 1, it is intuitively unlikely that C would assign a significantly high prior probability to F being type F_L (green) since the incumbent firms are not green; therefore, no message generally implies type F_H to C . Thus, the two equilibria that are of the most significance to this green game are those arising from outcome (b), i.e. zero conflict of interest, and outcome (c) which yields a mixed strategy.

8.5.3 Discussion of the Model's Applicability

In order to assess the empirical plausibility of the model it is necessary to make its assumptions, limitations and applicability explicit, given real-world complexities. The various caveats are considered in turn below, along with a discussion of the extent to which these caveats reduce the empirically applicability of the model outcomes.

(i) *Exogenous determination of the variable for green production*

The production process for the good (g_1) is pre-determined as either green ($\phi=\phi_L$) or not green ($\phi=\phi_H$). An alternative application might involve endogenising the variable to determine the optimal *ex ante* level of environmental impact that the firm (F) should choose given the alternative production processes for g_1 and the state of the market. The exogeneity assumption in this model is applicable for the short to medium term, where capital is fixed. It is not however a limitation to the applicability of the model: the assumption might be relaxed, with F modifying its production such that $\phi=\phi_L$ applies.

(ii) *Firm is assumed to know with certainty whether its product is green or not*

F is deemed to be certain of ϕ . This presupposes that F has the technical competence, resources and will to assess the full environmental impact of g_1 . Further, it assumes that it is indeed *possible* for F to determine with certainty whether $\phi=\phi_L$ or $\phi=\phi_H$ applies. As I have discussed above, the scientific determination of this state variable is complicated and problematic and thus the assumption that F has perfect and complete information might be heroic. It is however pertinent to note that the conventional environmental economics literature (e.g. Pearce and Turner, 1990) assumes that the firm is well informed about its production function and associated the marginal pollution abatement costs.

(iii) *Consumer is assumed to be incapable of independently determining greenness*

C assigns some anterior and posterior probability vis-à-vis ϕ . The reason for any divergence between these probabilities is assumed in the model to arise from the choice of F to send a message. The actions of consumer associations, the media and regulatory bodies might partially alleviate the informational asymmetry in the model. The extent of the potential market failure depends on this level of asymmetry. Although the transactions costs (to consumer bodies, NGOs *etc.*) associated with information dissemination might have been reduced owing to the internet, the asymmetry still applies if the consumer does not choose to expend the private transactions costs implied in information search, retrieval and synthesis. Applying the aforementioned consumer typology of Murphy (1989), electronic media might have impacted on the 'green thinkers' to a significant extent but perhaps less so on the wider 'green consumer

base'. The key fact here is that there is on-going evidence of greenwashing despite campaigning through electronic and more conventional forms of media.

(iv) *Perfect information is assumed to apply*

The model is one of perfect information, wherein both agents know with certainty the payoffs for each state-action pair. This implies *C* valuing the local environment with ($\phi=\phi_H$) and without ($\phi=\phi_L$) significant environmental degradation (although this valuation need not correspond with any other agent's valuation) and further being able to differentiate between the two states *ex post*. For *F*, this implies knowing the payoffs from *C* choosing *F*'s product (g_1) and the payoff (to *C*) from *C* choosing the competitor's product. The latter assumption is perhaps not too restrictive as market research is an on-going process for most firms – knowing what the consumer wants and the associated willing-to-pay. However, the ability of the consumer to determine the state of the environment *ex post* is perhaps the most restrictive condition vis-à-vis the empirical applicability of the model. In Scenario 1 the sensory attribute (the level of eutrophication) depends not only on the production system of the isolated farmer but also other extraneous factors such as weather conditions. Further, the assumption of 'isolation' wherein the level of eutrophication is assumed to be entirely attributable to the single agent is heroic⁶².

What are the consequences vis-à-vis empirical applicability if the green consumer cannot validate his purchasing decision *ex post* (i.e. attributes remain credence as opposed to sensory)? In such cases the model is still relevant if it is assumed that, even if the validation process for specific firms and purchasing decisions is imperfect, the consumer's (subjective) anterior probability that a given green marketing campaign is 'genuine' is affected by the prevalence of greenwashing *in general*. This is likely to be the case. Many consumers do not choose to expend the private transactions costs associated with gathering and assimilating information on the green credentials of a particular product/producer, but the build-up of general scepticism vis-à-vis green marketing affects their purchasing decision. What is happening here in essence is that those firms that are greenwashing are imposing a negative externality on those that are genuinely incurring costs to reduce the environmental impact of their products. This is discussed further below.

⁶² It is perhaps noteworthy that Coasian bargaining is routinely depicted in the literature (e.g. Pearce and Turner, 1990) as the negotiation between one affecting and one affected party, i.e. it is assumed that there is a single polluter and that the marginal damage function for the affected party arises singularly from its actions.

(v) *Single-shot game versus repeated game and reputation formation*

The model presented is a single-shot game, i.e. there is one iteration. This assumption is perhaps more applicable to certain types of commodity groups than others. The model is more applicable to those commodities that have a high level of profitability (i.e. the payoff to F) from a single transaction and longer average periods between purchases *ceteris paribus*. Examples of such commodities might include white domestic goods, whereas the model is less applicable to such goods as detergents or toilet paper. In the latter cases, there is a greater private benefit to the firm from reputation formation and a greater concomitant loss from losing 'repeat trade' if greenwashing is revealed to the consumer. Of course this does not imply that such product groups are free of greenwashing – only that the incentive for 'cheating' is lower.

8.5.4 Implications of the model

The previous section set out the limitations of the model with regards its applicability. On balance I would contend that there are most likely to be situations where a combination of asymmetric information and a sufficiently strong private incentive for greenwashing occur. Given this contention, what are the implications of the model? Scenario (b) above, wherein F 's payoff is positive given that g_1 is legitimately green and otherwise negative, appears intuitively socially desirable and 'fair'. An eco-labelling scheme might confer a solution in terms of achieving (b).

A significant assumption of the model is that of the realisation of the state variable (ϕ) is private information to F . However, consider a scenario where the following three conditions apply. First, in order that a good be accredited under the externally-verified eco-labelling scheme, it must have a low associated environmental loading. Second, accreditation is a legally binding requirement for any good claiming green credentials. Third, this information is disseminated to all agents in the market. Together, these three conditions are sufficient to ameliorate greenwashing. Under these assumptions, the model is radically simplified in that informational asymmetry no longer applies.

However, there are costs associated with eco-labelling in the form of transactions costs borne privately by the firm. Note that these are deadweight signalling losses – there is no improvement in environmental performance *per se* arising and signalling is costly. For instance, Vitalis (2002) (cited in Ibanez and Grolleau, 2008) reports that the certification costs for timber eco-labels are between 5 and 10% of existing logging costs. In the model, green marketing is feasible only under scenarios (b) and (c), respectively no conflict of interests and partial conflict of interests between firm and consumer. Under (c), F markets g_1 as a green good if it is

feasible and profitable to do so, regardless of whether the environmental impact associated with g_1 is high or low.

In order that green consumerism to be feasible under (c) in the model, certain conditions need apply. The condition that $b_L > b_H$ appears particularly restrictive, i.e. the payoff to a legitimate green marketing campaign strictly exceeds that of an illegitimate one. Given that ϕ is private information to F , and that ethical considerations do not impinge on F 's decision-making, there appears to be no valid justification for $b_L > b_H$. Even if this condition does apply, there are further restrictions under (c). In order that F 's campaign be perfectly 'instructive and trustworthy', the costs to F_H need to be prohibitive, i.e. $b_H < c(m)$. However, this seems (generally) empirically unrealistic⁶³. If $b_H > c(m)$ then C plays a mixed strategy, i.e. C 's posterior beliefs that $\phi = \phi_L$ are strictly less than one [$q(m) < 1$]. In summary, if C and F act in accordance with their optimal strategies, the scope for perfectly efficient green consumerism is probably restricted to scenario (b) with compulsory accreditation.

The answer to the question of optimal state intervention depends upon the disutility, or more precisely the loss of potential positive utility a_L or a_H , on those occasions when C chooses a good (g_1 or g_2) *ex ante* (applying the mixed strategy) which C would not have chosen given the information *ex post*. There is a second form of welfare loss in the one-shot game in the form of the potential negative externality imposed on genuinely green firms arising from the *ex post* revelation of 'cheating'. This can arise if the green consumer's subjective anterior probability that green marketing signals sent by other firms are genuine is modified, as is likely to be the case when the consumer realises the 'true' value of ϕ after the purchasing decision.

There is the potential for a vicious cycle (under a repeated game format) that leads to market failure in this model, paralleling the seminal work on asymmetric information set out in Akerlof (1970) which considers asymmetry in the market for second-hand cars. In the Akerlof model, there are two categories of used cars: 'lemons' and 'non-lemons'. In both cases, there is an experience attribute that the consumer can only determine after the purchasing decision; for lemons/non-lemons, the vehicle reliability is low/high respectively and the associated maintenance costs are high/low respectively. Asymmetric information applies in that the seller is assumed to know with certainty whether the car being marketed is a lemon/non-lemon whereas the consumer does not.

⁶³ A necessary condition for the model to function is that $b_L > c(m)$. Thus, $b_H > c(m)$ only implies that the expected payoff to F_H from 'cheating' exceeds the cost of the message, given that the payoff to F_L exceeds that (fixed) cost and given incomplete information.

Assume the following notation applies: the consumer's prior subjective probability that the car is a lemon/non-lemon is $l/(1-l)$; the consumer's *ex post* maximum willingness-to-pay for a lemon/non-lemon is WTP_l/WTP_{nl} respectively; the seller's reservation price (i.e. minimum willingness-to-accept) for a lemon/non-lemon is WTA_l/WTA_{nl} respectively. The rational (risk-neutral) response of the consumer is to offer a price for the used car as follows: $[l(WTP_l)+(1-l)(WTP_{nl})]$. Under the assumption that the seller's reservation price for the lemon is lower than that for the non-lemon ($WTA_l < WTA_{nl}$) then the offer price might exceed the reservation price for a lemon but be strictly less than the reservation price for a non-lemon, i.e. $WTA_{nl} > [l(WTP_l)+(1-l)(WTP_{nl})] > WTA_l$. Since all parties are aware of this outcome, over time consumers rationally lower their subjective probability that any given car is a non-lemon, and concomitantly their reservation price for a non-differentiated car (i.e. $[l(WTP_l)+(1-l)(WTP_{nl})]$) falls. Under such conditions of asymmetric information the market fails and, under the Akerlof (1970) model, no non-lemons are marketed.

There are clear comparisons that can be made with the one-shot strategic game that I have developed for green consumerism. The equivalent potential market failure for this eco-labelling model takes the following form:

1. C has some posterior subjective probability $q(m)$ that $\phi=\phi_L$ for g_1 given, first, that F has chosen to send some form of green message and second, C 's prior beliefs about the ratio, i.e. $p/(1-p)$, of green messages in the market that are genuine ($\phi=\phi_L$) to those that are false ($\phi=\phi_H$);
2. if $b_H > c(m)$, then F_H plays a mixed strategy, and as a consequence so does C ;
3. the lower the ratio $p/(1-p)$, the lower the frequency of C selecting g_1 *ceteris paribus*;

It is perhaps noteworthy that Akerlof's seminal paper was initially rejected by prominent economic journals: reviewers contended that the existence of a seemingly functional market for used cars provided empirical evidence of the spuriousness of the model⁶⁴. Akerlof rebutted this criticism in that the model describes a *process* of market segmentation: the fact that the theoretical end-point is not observed (i.e. the malfunctioning of the used car market to the extent that no used cars are marketed) does *not* imply that asymmetric information is unproblematic. There is likely to be segmentation to some extent and this in itself is likely to reduce social welfare. The same argument applies to my model of green consumerism: some imperfect signalling is likely to persist, with green consumers playing a mixed strategy that in turn provides a sufficient market incentive for some producers for which $\phi=\phi_L$ applies, but not for all producers in this category.

⁶⁴ http://nobelprize.org/nobel_prizes/economics/articles/akerlof/index.html, accessed 02.05.2007

Even if the type of market failure characterised by the Akerlof (1970) model is likely to manifest itself to a lesser extent in green consumerism, there is still the potential for the *ex post* revelation of greenwashing in one industrial sector affecting another entirely unassociated sector. As discussed above, Soler (1996) proposes that instructive and trustworthy information is a critical factor in green consumerism, a proposition corroborated by the survey results reported in Burnside (1990) that found that 56% of respondents were suspicious of 'environmentally friendly' claims. This is akin to a negative externality that produces the same effect as the informational asymmetry in Akerlof (1970).

The issue of whether or not such a regulatory intervention is economically efficient depends on the extent of the welfare loss arising from the asymmetric information and the cost of the intervention. There are complications associated with estimating or measuring both of these elements of the efficiency equation. On the cost side, there are the certification expenses for any mandatory scheme used. These include private costs borne by the firm (labour, materials and any scheme fees) and any social costs borne by the regulator over and above those met by certification fees. There are potential complications in avoiding double-counting, for instance how to attribute the salary and overhead costs of environmental managers across all their activities, one of which is the certification process⁶⁵. These complications are however small in relation to those associated with the estimation of welfare losses from asymmetric information.

A first and fundamental question that needs to be addressed is this: since the green attribute is normally a credence attribute, does the green consumer's utility depend on the value of ϕ *per se* or does it depend instead on what he or she *perceives it to be*? In the green signalling model, the two are equivalent owing to the assumption that the environmental state ($\phi=\phi_L$ or $\phi=\phi_H$) is revealed, but this is unrealistic. If $\phi=\phi_H$ applies and the green consumer is duped and never finds out, does this matter? In terms of personal utility, it probably does not. Notwithstanding this, there is a *social* (as opposed to private) welfare consequence of this outcome as the condition of the natural environment affects social welfare. The higher is the proportion of signals being sent by F_{CHEAT} where $\phi=\phi_H$ applies the less is the positive contribution of green consumerism in aggregate to reducing the burden of industrial production on the environment.

It is very difficult to estimate the welfare loss from asymmetric information as the extent of greenwashing is itself virtually impossible to measure reliably. Although F_{CSR} by definition would never intentionally send a false or misleading signal, F_{LAW} and F_{CHEAT} would do so and

⁶⁵ I discuss this with reference to regulatory impact assessment in MacLeod *et al.* (2009).

of course would not reveal that they had done so. As mentioned above, a standard economic assumption is that firms have a higher capacity and incentive to determine the environmental state ($\phi=\phi_L$ or $\phi=\phi_H$) but they also have the lowest incentive to reveal the true state if $\phi=\phi_H$ applies. The 'whistle-blowers' for greenwashing have to date primarily been environmental NGOs which are much less well-resourced than large corporations and which apply an *ad hoc* as opposed to systematic approach to evaluating corporate environmental claims. It is thus difficult to apportion percentages to genuine *versus* false claims. Similarly, the second potential 'knock-on' externality discussed above in the form of a general apathy or even antipathy to the green agenda arising from the green consumer learning that he or she has been duped is difficult to measure with any precision.

What is clear from the model is that there is the potential under the extant market conditions and asymmetric information for a market failure that worsens over time. This is the core outcome of the model. It may well be economically efficient to intervene to reduce the incidence of greenwashing. One form of intervention to achieve this is mandatory labelling and/or accreditation of green marketing claims.

8.6 Empirical evidence on corporate motivations for eco-labelling

There are two sides to the eco-labelling coin: the demand side and the supply side. In terms of empirical work pertaining to eco-labelling, the demand-side has been fairly well researched (see Section 8.2) but there is a dearth of evidence/literature on firms' motivations for participation (or not) on the supply side. In a well-functioning market with perfect and complete information a discussion of the supply side is somewhat superfluous: firms respond to changes in consumer preferences or are otherwise driven from the marketplace. I have challenged this NC economic worldview of competitive market behaviour and efficient corporate responsiveness in previous chapters. However, green marketing takes place under conditions of asymmetric and imperfect information and as such there is a potential market failure, even under neo-classicism. Thus an empirical analysis of the incentives for and impediments against firms' participation (and non-participation) in voluntary eco-labelling schemes is of interest and constitutes the content of this section.

The sample consisted of both UK and German firms within the chemicals industry, *viz.* paints and coatings. The coatings sector was chosen over other sectors within the chemicals industry as there currently are (and were at the time of survey) two extant eco-labelling schemes in the 'indoor paints and varnishes' sub-sector across the two study nations, i.e. the Blue Angel and the EC Eco-label. The coatings industry constitutes around 5% of the chemicals industry world-wide and is constituted by a few very large and dominant firms with a substantial number of

SMEs (Meredith and Wolters, 1996). Like the pharmaceuticals sector, it is highly dependent on the wider chemicals industry for raw material inputs. In both Germany and the UK, the market is fairly evenly split between the decorative sector and industrial coatings, the two sub-sectors being relatively independent vis-à-vis production and marketing strategies (*ibid*).

Volatile Organic Compounds (VOCs) used in paints and varnishes are perhaps the most significant ecosystem impact arising from the product life cycle. VOCs contribute to stratospheric ozone depletion and to the development of ground level ozone and some are toxic and/or carcinogenic (*ibid*). The European Union VOC Directive (1999/13/EC)⁶⁶ was passed in March 1999 and adopted by member states by April 2001; it set emission limits in terms of maximum solvent concentrations in waste gases. Aside from VOC, there are other environmental criteria that are common to both the EC Eco-label and the Blue Angel. Alongside the need to comply with these mandatory regulations, firms in the coatings sector can voluntarily apply the principles set out in the chemical industry's Responsible Care programme.

A survey (see Appendix 3) was constructed in May 2001 after consultation with both the German and UK coating industry associations. The principal aim of the survey was to determine the reasons why firms in this sector had chosen to apply for /not apply for one or both of the extant eco-labels. The survey was piloted in May 2001 and sent out in June 2001 by post to a sample of 220 firms that were randomly selected from the membership database of the German and UK trade associations. The survey questionnaire was split into three principal sections: firm characteristics; corporate environmental management in general; incentives for eco-label adoption/impacts of adoption if applicable. Results pertaining to these three sub-sections are presented in Sections 8.6.1-8.6.3.

8.6.1 Firm characteristics

Survey response rates are summarised in Table 23. Of the 220 questionnaires sent out, there were 28 usable responses, implying a response rate of around 13%. There were 10 usable responses from the UK firms and 18 from German firms. The sample size for Germany was intentionally higher than that for the UK (156 and 64 respectively) primarily to increase the probability of receiving usable responses from firms that had chosen to apply for an eco-label as the adoption rate of the Blue Angel is higher. As of June 2007, there were 695 products listed under category RAL-UZ 102 (low emission wall paints) and 1102 under RAL-UZ 12a (low pollutant paints and varnishes) for the Blue Angel⁶⁷. By comparison, there were only 35

⁶⁶ <http://ec.europa.eu/environment/air/pollutants/stationary/solvents.htm>, accessed 10.09.09

⁶⁷ http://www.blauer-engel.de/englisch/navigation/body_blauer_engel.htm, accessed 15.06.2007

products available in the UK that were certified under the EC Eco-label in the 'indoor paints and varnishes' category and 438 in total in this product category⁶⁸. Given the substantially higher number of German products in this category labelled under the Blue Angel as compared with the EC Eco-label, the likelihood of a randomly selected German firm being certified under at least one of the two schemes is thus higher than a UK equivalent.

Table 23 Paints and coatings survey: survey response rates

	UK	Germany	Total
Sent	64	156	220
Usable replies	10 (16%)	18 (12%)	28 (13%)

15/28 (54%) of the respondents were predominantly producing for the industrial coatings sector, 10/28 (36%) for decorative sector and 3/28 (9%) did not reply. This distribution within the sample corresponds reasonably well with the industry average split between these sub-sectors. Table 24 sets out some of the summary firm characteristics. The majority of firms that responded had a workforce of less than 250 employees (19/27, i.e. 70%). This is one of the two defining features of SME status under the EC definition, the other being a turnover of less than 50 million Euros⁶⁹. The sample thus seems to correspond well to the observation in Meredith and Wolters (1996) that the sector is made up of a few very large firms with a substantial number of SMEs.

The spending on R&D as a percentage of annual gross turnover is relatively small as compared with the pharmaceuticals sector; some new product development also takes place in specialist research centres such as 'Deutsches Lackinstitut' in Germany and the Paint Research Association in the UK.

⁶⁸ <http://www.eco-label.com/default.htm>, accessed 15.06.2007

⁶⁹ http://ec.europa.eu/enterprise/enterprise_policy/sme_definition/index_en.htm, accessed 15.06.2007.

Table 24 Paints and coating survey: firm characteristics

		Number of respondents
Employees	1-19	2 (7%)
	20-49	8 (29%)
	50-99	4 (14%)
	100-249	5 (18%)
	250-499	3 (11%)
	500-1499	3 (11%)
	1,500+	3 (11%)
Annual gross turnover (£million) ⁷⁰	<5	7 (25%)
	5-10	3 (11%)
	10-50	7 (25%)
	50-100	2 (7%)
	100-500	3 (11%)
	n.a.	6 (21%)
R&D spending (% annual gross turnover)	1-4	11 (39%)
	5-10	8 (29%)
	>10	1 (4%)
	n.a.	8 (29%)
Export trade (% of total sales volume)	0-5	9 (32%)
	6-20	11 (39%)
	21-40	6 (21%)
	>40	2 (7%)
Part of multinational		7 (25%)
-with environmental strategy		5 (18%)

With respect to export trade as a component of total sales, the respondents to the survey predominantly operated in the domestic market with only 8/28 (29%) stating that exports accounted for more than 20% of total sales volume. This is perhaps linked to the fact that many of the firms both in the sector and in the respondent sample are SMEs and not part of a multinational parent firm

8.6.2 Corporate environmental management

The second sub-section of the survey dealt with environmental management tools in general. As discussed above, the production of paints and varnishes has a relatively high ecosystem impact relative arising from emissions of VOCs, ground level and stratospheric ozone (EC, 2001b). The level of mandatory environmental regulation that the sector is subject to is commensurately high. Environmental management tools function as compliance monitoring. As such, the level of adoption/application of various environmental management tools was high across the sample of respondents. The results from this section of the survey are set out in Table 25.

⁷⁰ Conversion to UK Sterling at the exchange rate that applied at the time of survey, i.e. 1.59EUR=1£

Table 25 Paints and coatings survey: application of environmental management tools

<i>Environmental Policy Tool</i>	<i>Number</i>
Coatings Care	17/28 (61%)
EMS	14/28 (50%)
Certified EMS	10/28 (36%)
Environmental Reporting	13/28 (46%)
Environmental Impact Assessment	6/28 (21%)
Environmental Auditing	10/28 (36%)
Life Cycle Assessment	5/28 (18%)

It is perhaps noteworthy that LCA has the lowest adoption rate across the respondents; LCA is used in the appraisal of product performance in certified eco-labelling schemes. The 5 respondents that stated that they were using LCA were also the largest firms (as measured by annual gross turnover). This relatively low adoption rate in the smaller firms is however not unexpected. An EMS provides a quality assurance system that documents good practice and indeed non-compliance/the actions required to deal with non-compliance. As such it provides evidence of intra-firm environmental protocols that can be used in legal defence. Environmental reporting and corporate environmental auditing again provide data that is useful to and impacts on the private cost-benefit appraisal that a firm makes of its own activities. By contrast, LCA by definition is concerned with not only what happens in the factory gates but the ecosystem impact from cradle-to-grave, i.e. from raw material extraction to final use/disposal. These extra-firm impacts do not directly impinge on the firm's bottom line (unless they affect green consumerism) and thus are likely to be a lower priority. The most widely applied tool among the respondents was the industry association's designated environmental programme termed Coatings Care; this is perhaps a consequence of the need to be in line with (and to be seen to be in line with) the sector's voluntary code of best practice.

Having analysed what the firms are doing, the next sub-section of the survey used a 5-point Likert scale was used to assess the firms' motivations for adoption of environmental management in general. The results are set out in Table 26. The results vis-à-vis the means and standard deviations are perhaps not very revealing as many respondents gave a value of 5

(extremely important) or 4 (very important) for several of the drivers for environmental performance improvement⁷¹.

Table 26 Paints and coatings survey: motivations for improving environmental performance

<i>Reason for improving corporate performance</i>	<i>Mean</i>	<i>Standard deviation</i>	<i>Most important reason</i>
New technologies	3.86	0.80	2/28 (7%)
Improving company's reputation	3.66	1.10	7/28 (25%)
New national legislation	3.79	0.99	10/28 (36%)
New international legislation	3.68	0.98	2/28 (7%)
Increased competition	3.18	1.02	1 (4%)
Shifting consumer preferences	3.82	0.98	3/28 (11%)
Pressures from local community	2.82	1.02	2/28 (7%)

What is noteworthy is that, in an industrial sector with a high perceived and actual environmental impact, 'shifting consumer preferences' was only cited as the most important commercial motivation by 3/28 respondents. However a caveat should be applied in that 7/28 stated that 'improving company's reputation' as the most important driver. This improvement in reputation pertains to all stakeholders, one of which is the firm's current (or potential) consumer base. Thus part of this 7/28 first place ranking might be attributed to consumer demand side. Further, in response to the question pertaining to trends in green consumerism, 12/28 replied that they foresaw demand for green products 'increasing significantly' and 12/28 'increasing'. No respondent saw green products becoming 'market dominating' and on the other end of the spectrum there were 0 responses for 'decreasing', with 4/28 predicting a 'stable' market.

8.6.3 Incentives for eco-label certification/impacts of adoption

Perhaps the most striking (although not unanticipated) result from this segment of the survey was that only 1/10 UK firms (10%) had an eco-label as compared with 8/18 German firms (44%), the single UK firm being certified under the EC Eco-label and all 8 of the German firms under the Blue Angel. Although the sample size is small (28 respondents), it appears from this result that one or more of the following applies: German stakeholders are more aware of and responsive to any form of accredited eco-label as compared to their UK equivalents; the Blue Angel is more influential than the EC Eco-label in its home market and the awareness of the

⁷¹ This is one of the standard criticisms that I have made in earlier sections with regards the application of the Likert scale and one that is addressed by the application of analytical hierarchy process in the survey reported in Chapter 3, although the latter has its own methodological weaknesses.

former (the critical mass developed) as compared with the latter is critical. There is no evidence from the literature that UK consumers are laggards vis-à-vis green consumerism and so it would appear that the latter reason for the significantly higher uptake rate by the German sub-sample is more influential. The summary tables (Tables 27-29) provide some further evidence in this regard.

Table 27 Paints and coatings survey: reasons for eco-labelling applications

<i>Reason for applying/planning to apply for an eco-label (11 responses)</i>	<i>Mean (range 1-5)</i>	<i>Standard deviation</i>
Plays a part in protecting the environment	3.09	1.22
Customer expectations	3.91	0.94
Improves chances of product being selected	3.91	0.94
Gain competitive advantage through early adoption	3.73	1.19
Response to adoption by competitors	3.45	1.04
Enhance the image of the company	4.00	1.00
Meet the needs of the retail trade/supplier challenges	2.45	0.93

The most significant reasons for adopting the eco-label as set out in Table 27 are demand-driven, i.e. customer expectations, the associated increased chance of the consumer buying the product and company image. Supplier challenges are less significant as a driver.

Table 28 Paints and coatings survey: reasons for not applying for an eco-label

<i>Reasons for not applying for an eco-label (13 responses)</i>	<i>Mean (range 1-5)</i>	<i>Standard deviation</i>
Products do not fall into the eco-label category	4.46	0.88
Eco-label criteria inconsistent with available technology	1.31	0.63
Benefits of eco-label not proportional to costs	2.38	1.26
Application procedure too lengthy	2.00	1.29
Communication with competent body poor	1.85	1.28

For those that had not applied for an eco-label (Table 28), by far the most significant reason cited was that the firm's production did not fall into an eco-label category. This response may of course be valid in some proportion of cases but there are likely to be instances where the firm is misinformed about the available product categories and the associated criteria. Perhaps the most significant outcome vis-à-vis non-participation is the relatively low significance of the disproportionality question, i.e. the costs outweighing the benefits of certification. However, a

caveat must be applied here: if the firm (correctly or erroneously) perceives that its products do not fall into the eco-label categories (a high mean of 4.46/5) then the respondent is perhaps unlikely to have done a thorough private cost-benefit appraisal of the eco-labelling schemes. The same caveat must then be applied to the other responses to potential reasons for non-application set out in Table 28. Table 29 summarises the respondents' perception of the effects arising from eco-label adoption.

Table 29 Paints and coating survey: effects from applying an eco-label

<i>Effects of using the eco-label (9 responses)</i>	<i>Mean (range 1-5)</i>	<i>Standard deviation</i>
Improvement in market position	2.67	1.12
Image of the firm improved in the public eye	2.78	1.30
Increased sales in the ecolabelled products	2.11	0.78
Business partners shown support for ecolabel adoption	2.89	1.05
Employees shown support for ecolabel adoption	2.44	1.01

As mentioned above, 8/9 eco-label adopters were German and applied the Blue Angel as opposed to the EC Eco-label. The sample size of only 9 is restrictive with respect to the interpretation of results. Notwithstanding this caveat, all response means are in the range 2-3 and the mean for what is perhaps the critical effect - increased sales - is low at 2.11. Thus it would appear that the effects of green consumerism are perhaps only mildly positive for the (admittedly small) sample of respondents with an extant eco-label.

8.7 Chapter conclusions

I would contend that the efficacy of green consumerism is an important determinant of the rate and direction of corporate change with regard to sustainability. It is potentially one of the critical 'carrots' that co-exists with the 'sticks' of legislation and penalties. I have outlined the seminal Lancaster-Rosen approach (Lancaster, 1971) to product differentiation and selection in the market, *viz.* the perceived attributes of a product versus competing choices. I have also presented empirical evidence from the literature on the proclivity of some sub-set of consumers to be willing-to-pay a premium in the market for the green attribute. Thus even under extant market conditions there is a potential green 'cake' distributed amongst firms.

It is the nature of these extant market conditions that has been the theoretical focus of this chapter. 'Greenness' is typically a credence (as opposed to being either a sensory or an experience) attribute. As such, consumers who are willing-to-pay a green premium cannot in many cases validate their individual purchases *ex post*, let alone *ex ante*. This turn means that

there is a potential opportunity for non-green products to be marketed as green (i.e. greenwashing) in order to get a slice of the green cake.

Why would a firm choose to greenwash? I have characterised the population of firms to be composed of three types: F_{CSR} ; F_{LAW} ; and F_{CHEAT} . Firms in the latter two categories have the potential to knowingly send false or misleading green signals. For both, the decision as to whether or not to greenwash depends on the expected costs and benefits of the green marketing signal sent to consumers; the distinction between the two sub-populations is that a second condition applies for F_{LAW} , i.e. such signals are sent if and only if the marketing is legally defensible. This balance of costs and benefits depends on expectation concerning a number of factors, *inter alia* risk strategies (risk aversion/neutrality/taking), the probability of being caught, the penalties applied (both regulatory and market), the extent of the profitability benefit from attracting the green consumer. It is quite feasible that firms' perceptions of these costs and benefits are unrealistic but the critical outcome is that there is evidence of greenwashing taking place. The reasons it *can* take place is the regulatory framework, the existence of a credence attribute and asymmetric information vis-à-vis this attribute. The reason it *does* happen is the profit motive based on the appraisal of expected private cost and benefits to the firm.

Mandatory eco-labelling and/or third party certification is one potential solution to ameliorate this market failure that arises from information asymmetry. However it is not a complete solution. A review of extant Type 1 eco-labels reveals that there is a lack of homogeneity across schemes and the potential for harmonisation of the schemes is low. However I argue that the more substantive issue is the co-existence of unsubstantiated green claims and externally-verified ones. In order to assess whether or not mandatory certification is a form of economically optimal regulatory intervention it is necessary to evaluate the costs and benefits. In the terminology of the model developed in Section 8.5, optimality depends upon the disutility, or more precisely the loss of potential positive utility a_L or a_H , on those occasions when C chooses a good (g_1 or g_2) *ex ante* (applying the mixed strategy) which C would not have chosen given the information *ex post*. There is also a second potential form of welfare loss if the green consumer's subjective anterior probability that green marketing signals sent by other firms in other *unrelated* industries is modified.

There is a further issue with regards green consumerism: the potential for a self-reinforcing vicious cycle that characterises the market for a credence attribute. The strategic behavioural model set out in this chapter reinterprets the seminal signalling game of Akerlof (1970) to green consumerism: under asymmetric information and *ceteris paribus* conditions, the proportion of genuine claims to false claims (greenwashing) is likely to decrease over time. It is perhaps

interesting to note that both the criticism (and response) of the Akerlof (1970) model applies to Hussain (2000): there is unequivocal empirical evidence that firms are marketing products as green and charging a premium and so surely the market is functioning. The retort is as follows: the market does indeed function but would *function better* were this informational asymmetry to be ameliorated, i.e. it is not all or nothing.

In some respects the theoretical constructs in this chapter do not lend themselves to empirical investigation: greenwashing by definition is not openly revealed by firms. However it is relevant to conduct an empirical analysis of the incentives for and impediments against firms' participation (and non-participation) in voluntary eco-labelling schemes. Section 8.6 documents and discusses the results of a survey of both UK and German firms within the chemicals industry. The coatings sector was chosen owing to the co-existence of two eco-labelling schemes, i.e. the Blue Angel and the EC Eco-label. The main findings of this survey are that the most significant reasons for adopting eco-labelling are demand-driven, i.e. customer expectations, the associated increased chance of the consumer buying the product and company image. An unexpected outcome is that non-participation is *not* cited as being driven by disproportionate costs relative to perceived benefits; the most significant reason cited is that the firm (correctly or erroneously) perceives that its products do not fall into the eco-label categories (a high mean of 4.46/5). The results in terms of the effects of eco-labelling are equivocal, in part owing to the small sample of respondents: the response is only mildly positive and the mean value for what is perhaps the critical effect - increased sales - is low at 2.11/5. Notwithstanding the sample size issue, this result implies that the eco-labels are not perceived to be delivering private benefits to the firm. Although this perception unto itself is important in the context of voluntary labelling, this low perceived impact might arise because of the context in which eco-labelling takes place. I would thus contend that this result does not undermine the fundamental proposition of this chapter that eco-labelling has significant potential (that in part has already been realised) as a demand-side carrot for eco-reform but that current conditions might be stifling its impact.

9 CONCLUSIONS

The core theme of this thesis has been the evaluation of environmental regulation vis-à-vis economic optimality. It has not been an evaluation of specific environmental policy *per se* but what constitutes 'good' environmental regulatory intervention with a focus on corporate environmental management tools. The designation of what is 'good' (as opposed to inappropriate or welfare-reducing) regulatory intervention is multi-faceted and I have attempted in this thesis to deconstruct this into its two constituent elements. First, there is the socio-political decision on regulatory *stance* vis-à-vis the roles and responsibilities of the regulator and the regulated: this is the institutional context for decisions. Second, there is the *prediction* of the response of different agents in society to the policies arising from this stance. The *evaluation* of what is the 'best' regulatory option depends on the relative merits/demerits of alternative states of nature that might arise, along with the probability of their arising (i.e. the predicted response).

Throughout this thesis, I have set out, criticised and contrasted the stance and behavioural assumptions made of different agents (i.e. predicted responses) under two competing perspectives that might be broadly termed conventional NC economics and ecological economics. This is of course a broad-brush characterisation but I would argue a useful one in that there are parallels that can be drawn between consumers and firms in this regard: those agents that respond to the sustainability agenda based on a sense of duty and social *responsibility* versus those that simply *respond* to it a potential modifier of private welfare. This black-and-white characterisation is simplistic (and I discuss the shades of grey in the thesis) but it is useful in allowing the outcomes of this research to be synthesised. These outcomes pertain to the Objectives 1-6 set out in Chapter 1. Each is re-stated in turn below and the outcomes pertaining to each set out.

Objective 1 Define the role of the firm in society vis-à-vis the sustainability agenda in conceptual terms, i.e. what the rights and responsibilities of firms *should* be and, given this, what is the role of the state?

Under any conceivable market structure and in the context of any regulatory framework there will always be the potential to change the *modus operandi* of firms such that the negative impact of production on the natural environment is reduced. Firms are not at some eco-friendly cusp. The greening of industry literature is pervaded by a didacticism vis-à-vis how far firms should go in terms of eco-reform, a didacticism that ought to be questioned but rarely is.

The NC argument stems from functional theory and utilitarianism (Uyl, 1994) and the associated influential work of Milton Friedman (Friedman, 1963; Friedman, 1970). I have argued that Friedman's "sanctity of the contract" (Friedman, 1970) between a firm's owners and operators is ethically moribund and anachronistic. If a firm's fiduciaries choose to green the firm at the expense of profitability then this is simply a form of self-interested behaviour on the part of the fiduciary. I have argued that there cannot be a hierarchy of self-interest, *viz.* the need for the firm under functional theory to be self-interested (and therein maximise profits) cannot dominate the needs of fiduciaries to feel a sense of personal well-being arising from actions in the corporate domain that account for other (i.e. non-shareholder) stakeholder needs. Utilitarianism supposes welfare is synonymous with income-generation and consumption; I have argued for the position of the humanist school (e.g. Max-Neef, 1992; Daly, 1992) that such a position is both morally objectionable and indeed not descriptively accurate. This further weakens the "sanctity of the contract".

Does this synopsis imply that that the evangelical zeal of such authors as Roddick (1992) is in fact justified? I have argued that this is not the case: the ethical foundations of social permission theory (Granovetter, 1991) are just as shaky as those of functional theory. The notion that the firm is a 'trustee' of societal resources (Davis, 1983) implies a diminution of fundamental property rights in society.

I have thus argued that the resolution of the ethical question should be based on 'I&We' deontological theory (Etzioni, 1988) which is closer aligned with an ecological economics perspective. 'I&We' balances egoism and extra-individual duty, the latter arising from the norms, cultures and values of stakeholder groups that the agent is a member of. In some respects, the outcome of my ethical investigation vis-à-vis what firms *should* do appears bland and inconsequential in that the application of 'I&We' is empirically descriptive of most firms' behaviour, i.e. it is what they do *in practice*. My argument is that such behaviour is ethically appropriate and that *there is a need to justify it* in that both functionalism and social permission theory have their advocates and both suggest alternative perspectives on the state/firm interface.

As part of this ethical investigation I also applied AHP to determine what firms' fiduciaries themselves saw their role to be (Chapter 3). In some respects the AHP study straddled two segments of this research: the stance of the regulated and the prediction of the response to policy intervention. The latter to an extent depends on the former. The AHP study allowed respondents to reveal motivations based on 'pure' functional theory or 'pure' social permission theory. In practise no respondent did so. What the study elicited was the respective contribution

of 'I' and 'We' (Etzioni, 1988). The principal findings were that the drivers that might be linked to CSR (the environmental and social benefits arising from the EMS) were amongst the least significant drivers whilst long term profitability was clearly the strongest driver. In both the AHP and the analysis of drivers for EMS adoption, the 'carrots' of profitability and niche marketing were marked higher than the 'sticks' of regulation and community and/or NGO pressures. This result is of consequence for the focus on just such a 'carrot' in the latter sections of this research, *viz.* eco-labelling.

Objective 2 Outline and critique methods to measure corporate sustainability, i.e. determine whether we can reliably chart progress in terms of what they are *actually doing* in terms of delivering corporate sustainability

The paradigm of sustainable development was found to have become firmly established both in the policy-making domain and in academia. Recent surveys have attempted to chart the development of tools to 'operationalise' the paradigm (e.g. Mayer, 2008; Bohringer and Jochem, 2007). Many of the fundamental issues that pertain to quantitative multi-dimensional sustainability indicators in general (e.g. data integrity; comparability across indicators; aggregation of individual indicators into indices versus non-aggregated frameworks) apply as much (if not more) to industrial sustainability measurement.

Industrial sustainability *reporting* has been promoted by the GRI, focusing more on management *processes* than sustainability performance *per se*. I have argued that an outcome of this focus is that firms opt into this framework on the grounds of funding priorities and the expected payoff from signalling their involvement in GRI. The former implies that larger firms have a higher proclivity to opt in. The latter implies that those firms that have more to gain from the endorsement afforded them by opting into GRI do so, but this may not coincide with high sustainability performance. Unlike the analysis pertaining to eco-labelling (Objective 5) this is not greenwashing *per se*. However participation in GRI might give the uninformed consumer the imprecise impression that performance (as opposed to process) is being externally-validated.

The data collected as part of the GRI have however contributed to developments in the academic domain vis-à-vis measuring corporate sustainability which I have discussed. SVA (Figge and Hahn, 2004) and DEA (Callens and Tytca, 1999) share the following characteristics: they are based on a process of benchmarking which can be extended to encompass socio-economic criteria; the datasets used are relatively reliable; and they link the analysis of environmental impact back to financial performance in a uni-variate indicator.

However I have argued that the lack of weighting applied to the various attributes is inappropriate, and this applies to both methodologies. The trade-off is between the inaccuracies of environmental valuation versus the systemic error arising from assuming that all attributes are equally as influential in determining industrial sustainability. I have argued that erring on the side of valuation is preferable to abstaining from the weighting issue altogether.

I have outlined two methodologies that both summarise industrial sustainability in a uni-variate measure *and* apply weighting: Genuine Savings (Atkinson, 2000) and EFA (Wiedmann and Lenzen, 2006), the former being aligned more with the NC perspective and the latter with ecological economics. The former monetises environmental impacts where possible but only a small sub-set of impacts can be estimated unless new primary valuation studies are conducted. Further, there is no industry-level benchmarking. The latter is more complex in that all environmental impacts are collapsed into a non-monetised measure (gHa) that allows the juxtaposition of anthropogenic environmental appropriation with biocapacity. Despite the limitations of EFA set out, I have argued that EFA has much to offer in terms of ‘operationalising’ corporate sustainability: it allows benchmarking; it captures the multi-dimensionality of industrial environmental sustainability in a uni-variate measure; and there are different composite elements (e.g. sea footprint, pasture footprint *etc.*) that are weighted. Further, carbon footprinting has very much entered the public mindset. I have argued that although carbon footprinting is only a sub-set of EFA, the momentum generated by the former is likely to stimulate the uptake of the latter.

Although corporate sustainability is difficult to measure, progress in terms of what firms are actually doing in this regard *can* be charted, notwithstanding the fact that the methodological options that I have suggested are best suited to doing this have not been applied extensively to date.

Objective 3 Outline and re-conceptualise the *extant arguments* for regulatory intervention given the *status quo* vis-à-vis corporate sustainability

The extant argument for regulatory intervention from NC economics stems from the need to internalise a pollution externality and has been conceptualised in terms of MAC and MEC curves intersecting at the social optimum. I have re-conceptualised this argument in terms of the PH and what it implies with respect to the *shifts* in the MAC curve and the associated implications for optimal intervention, particularly under conditions of asymmetric information between the state and the polluting firm.

The PH provides an important context to the overall research in that it is concerned with the optimality or otherwise of applying more stringent environmental legislation. The core PH argument is that the search for pollution offsets occurs if and only if the ‘stick’ of mandatory regulation is applied. Porter claims an additional benefit in terms of the potential to export these environmental technologies to other countries that have not benefited from the learning-by-doing process. In my re-conceptualisation of the standard externality analysis, the core assumption of a shift in MAC curve depends on three conditions: (i) the MAC curve captures marginal abatement costs *net of the private benefits of abatement*; (ii) the MAC is based on the *extant information set* of the polluter vis-à-vis opportunities for abatement; and (iii) the MAC is based on *extant market and institutional conditions*. Condition (i) allows for the MAC curve to be negative. Further, I have argued that changes pertaining to conditions (ii) and (iii) can imply a shift in the demand for green products and thus an inward shift in MAC; it is now more costly to pollute as in so doing the likelihood of winning the green consumer market share is diminished commensurately.

What this re-conceptualisation implies is that, even under conditions of certainty, Porter’s contention that offsets will exceed abatement costs is a sufficient *but not necessary* condition for stricter legislation as the decrease in the social costs associated with environmental pollution should be factored in. Under conditions of uncertainty and asymmetric information there is an incentive for the polluter to attempt to ‘cheat’ the regulator into believing that MAC is punitive. With the presumption of the MAC curves shifting inwards there is a concomitant convergence between the private and social optima and diminution of the potential welfare losses from successful cheating.

Meeting this objective of re-conceptualisation based on the PH is an important as the extant arguments for regulatory intervention then depend on the MAC curve *not* shifting. Outcomes from the objectives that follow suggest that this assumption may not apply.

Objective 4 Set out the conditions that determine the *supply* of corporate sustainability, i.e. the adoption of eco-innovations

Any eco-innovation process is determined by stimuli from within the firm’s ‘black box’ and from the business environment in which the firm operates. I have set out the conditions pertaining to both; together they determine the supply of corporate sustainability. I have set out the arguments of the various competing schools within the NC tradition that consider innovation-adoption in general (e.g. Ruttan, 1996; Mowery and Rosenberg, 1979; Ahmed, 1966) and formulated adapted versions pertaining to eco-innovations by explicitly introducing

natural capital inputs. These NC traditions purport that natural capital factor input prices and/or availability determine the extent to which innovation seeks to 'economise' on these inputs. The prescriptive outcome of this NC analysis is that natural capital inputs should be priced so as to reflect their respective true shadow values; various factors contribute to this not happening including perverse incentives for resource over-extraction and indirect use values (such as ecosystem service provision) not being accounted for (Edwards-Jones *et al.*, 2000). Although correcting for such instances of market failure is a valid form of economic intervention, I have argued that it is not the complete answer with regards eco-innovation adoption.

The reason for this is that the assumption that correcting prices leads to the optimal uptake of eco-innovations is arguably misguided: the evolutionary economic school suggests an alternative perspective. I have contextualised the Nelson-Winter models of routine-based search behaviour (e.g. Nelson and Winter, 1973) and Simon's 'satisficing' conceptualisation (Simon, 1955; 1959) to eco-innovations and have argued that they appear more theoretically plausible than the traditional NC perspectives vis-à-vis innovation-adoption in general and eco-innovations in particular. The Nelson-Winter models suggest that the trajectory of innovation-adoption depends on the firm's history of innovations: one iteration towards an eco-innovation generates momentum such that an eco-innovation is more likely to be selected at the next iteration *ceteris paribus*. The Nelson-Winter theoretical perspective is sympathetic to the PH: if it is indeed the case that this routine-based mode of firm decision-making is empirically descriptive then this strengthens the case for the application of more stringent environmental legislation as this influences the innovation search process.

The broad aim of the study documented in Chapter 7 was to provide empirical evidence on the eco-innovation adoption process for the pharmaceuticals industry and therein to test the descriptive accuracy of NC versus evolutionary models. Under neo-classicism firms are assumed to be on or close to their efficiency frontiers and thus an eco-innovation would be adopted owing to a sudden shock to system equilibrium. When asked to designate the most significant eco-change in the firm, only 18% (5/27) described this change as a "one-off"; the global mean across all 23 designated variables that affect eco-change ('national regulation' *etc.*) was 25% for "sudden change". Further, 37% (7/19) cited resource constraints as a stumbling block, a result that challenges the presumption that firms are indeed perched at their efficiency frontiers vis-à-vis the uptake of opportunities for eco-reform. These results support the evolutionary economic perspective.

There are various results from the survey that support the PH. The most significant variables with regards the stimulus for the adoption of eco-innovations were national and EU regulation

(5.7/7 in each case). Thus the ‘stick’ of regulation was clearly regarded as being more influential than the ‘carrot’ of the market: ‘emergence of new industry niches’ had the lowest score of any variable tested (3.1/7). With regards the first-mover advantage purported in the PH, ‘early adopters’ showed a higher performance vis-à-vis the behavioural variable than ‘late adopters’ and ‘non-adopters’. The survey results also support the focus on eco-labelling as a potential driver for eco-innovation adoption. The variable most closely linked to green consumerism, *viz.* ‘shift in needs/values: national consumers’, was scored relatively highly (5.0/7).

The other analytical tract that I have considered with regards the supply of eco-innovations is the potential for systemic ‘lock-in’ (Arthur, 1989) to an innovation path that is unsustainable owing to the existence and network externalities. This can arise because of coordination effects and quasi-irreversibilities (David, 1985). I have coined the shift required to overcome such a network externality as a neo-Schumpeterian ‘search for new search routines’, wherein the new desired equilibrium is a transformative state that cannot be reached by the incremental steps of Nelson-Winter models. For instance, the rigours and requirements of extant supply chain networks might restrict the capacity for small-scale and/or local production to flourish. Lock-in links Objectives 4 and 5 as there may be coordination effects that apply in eco-labelling: potential applicants benefit from the visibility and consumer-awareness generated by products that are already in such schemes. If all products in a product category were to reveal their sustainability impacts simultaneously (i.e. in a coordinated manner) then this potential early-mover disadvantage would not apply. This disadvantage applies in that the firm incurs the costs of participation upfront but the private benefits depend in part on the participation rate of *other* products; there is thus an incentive to forestall participation.

Objective 5 Determine the behaviour of consumers in terms of the *demand* for corporate sustainability, in the form of purchases of eco-labelled products

I have argued that the efficacy of green consumerism is an important determinant of the rate and direction of corporate innovation-adoption. The first milestone in terms of meeting this objective is the determination of consumer decision-making *in general*. In this regard I have outlined the seminal Lancaster-Rosen approach (e.g. Lancaster, 1971), *viz.* perceived product attributes in competing choices. More specifically, ‘greenness’ is typically a credence (as opposed to being either a sensory or an experience) attribute. As such, consumers who are willing-to-pay a green premium cannot in many cases validate their individual purchases *ex post*, let alone *ex ante*. I have argued that this can affect the behaviour of both sets of agents (firms and consumers) in their strategic interactions as the empirical evidence (e.g. Bjorner *et*

al., 2004) suggests that there is a 'green cake'. In fact I have argued that owing to extant market conditions of asymmetric information, this cake may be smaller than might otherwise be the case and, all else being equal, would tend to *shrink further* over time. This is a striking outcome.

The reason that this outcome arises depends on the characterisation of firms and consumers in this potential green market. I have categorised firms as F_{CSR} , F_{LAW} and F_{CHEAT} . Firms in the latter two categories have the potential to knowingly send false or misleading green signals ('greenwashing'). For both, the decision as to whether or not to greenwash depends on the expected private costs/benefits; the distinction between the two sub-populations is that in the case of F_{LAW} a signal is sent if and only if it is legally defensible.

Mandatory eco-labelling and/or third party certification is one potential policy to ameliorate greenwashing. However it is not a complete solution. There is a lack of homogeneity across Type 1 eco-labelling schemes and the potential for harmonisation of the schemes is low. The economic optimality question requires the evaluation of costs and benefits. In the model developed in Section 8.5, I have argued that consumers are likely to play a mixed strategy with regards green marketing that they cannot substantiate. For green consumerism there is the potential for a self-reinforcing vicious cycle that characterises the market for a credence attribute. The strategic behavioural model set out reinterpreted the seminal signalling game of Akerlof (1970): under asymmetric information and *ceteris paribus* conditions, the proportion of genuine claims to false claims (greenwashing) is likely to decrease over time, *cf.* the shrinking green cake. There is clear evidence the market does indeed function for the green attribute but I have argued that it would *function better* were this informational asymmetry to be ameliorated, i.e. it is not all or nothing.

Although greenwashing cannot by definition be investigated through surveys, what I have investigated in Section 8.6 is the stimuli and impediments for eco-labelling in both UK and German firms in the paints and coatings sub-sector of the chemicals industry which has two eco-labelling schemes, i.e. the Blue Angel and the EC Eco-label. The main stimuli were revealed to be demand-driven ('customer expectations') but the mean value for 'increased sales' was low at 2.11/5. Notwithstanding the sample size issue, this result implies that the eco-labels are not perceived to be delivering private benefits to the firm to the extent that they might be.

Objective 6 Outline instances where the outcomes of the research point to the potential for the *status quo* vis-à-vis corporate sustainability to be adjudged economically inefficient, i.e. where extant arguments for regulatory intervention might be modified

The extant NC argument for intervention in the market vis-à-vis the sustainability performance of firms is that market failure should be corrected if and when it occurs: externalities should be internalised, market prices should reflect resource scarcity and consumer sovereignty should apply. The outcomes of this research suggest that there are reasons why regulatory intervention should be modified both from within this NC perspective and from an ecological economic world-view. These might be categorised as demand-side interventions and supply-side interventions.

On the demand side, the eco-labelling model developed (Hussain, 2000) shows that the *status quo* is potentially impeding green consumerism. The co-existence of third-party certified schemes and non-validated green marketing is problematic: there is an incentive for greenwashing; there is the potential for a self-fulfilling hypothesis in that the more consumers perceive greenwashing to occur the more likely it is to occur. This latter point is critical: this potentially degeneration in the market for green attributes implies that regulatory intervention should not only be determined by the current prevalence (and disutility) from greenwashing but expectations of on-going and worsening conditions for green consumerism if the *status quo* is preserved. This strengthens the case for mandatory certified eco-labelling.

On the supply side, the analysis has been coined with regards the PH. The broad NC perspective (e.g. Palmer *et al.*, 1995) is that the availability of pollution offsets has been overstated by proponents of the PH and thus more stringent environmental legislation is not welfare-improving. There are three theoretical insights from this research which contribute to the PH and therein slacken the conditions that must be met so as to make such legislation economically efficient.

First, there are the effects of shifts in MAC curves as opposed to movements along the extant MAC curve. If eco-innovations arising from more stringent regulation cause such a shift then there is a convergence between the privately optimal level of pollution and the social optimum. Given that regulation occurs under conditions of uncertainty this convergence is likely to imply that the deadweight losses arises from the strategic interactions between the polluter and the regulator are likely to be reduced.

Second, the evolutionary economics perspective (Kusterer and Hussain, 2001) suggests that the history of innovations is a determinant of firms' search/selection of innovation options. If more stringent environmental regulation stimulates eco-innovation then this leaves an indelible stamp on the firm's innovation record and therein influences not just current behaviour but also the *future* innovation trajectory. The NC perspective on regulation does not account for this.

Third, firms may be 'locked in' to unsustainable production systems (Hussain, 2004). Regulatory intervention might stimulate an amelioration of 'coordination effects' that allow such a lock-in to persist.

The research has not sought to determine explicitly whether a specific sustainability policy is appropriate. Without knowing the extent of asymmetric information and greenwashing (both of which cannot be determined with accuracy) and a wider cross-sector analysis of eco-innovation adoption it is not possible to make such policy prescriptions. However I contend that the development of the theoretical arguments and the limited empirical testing herein are still of significance and contribute to the state of the art in this field of academic enquiry.

REFERENCES

- ABPI (Association of the British Pharmaceutical Industry) (1999) *ABPI Full Member Organisations, 1999*. <http://www.abpi.org.uk/> (accessed 08.07.1999)
- Abraham, J. (1995) *Science, politics and the pharmaceutical industry*. UCL, London.
- Achilladelis, B. and Antonakis, N. (2001) The dynamics of technological innovation: the case of the pharmaceuticals industry. *Research Policy* 30(4):535-588
- Ahmad, S. (1966) On the theory of induced innovation. *Economic Journal* 76:344-357.
- Akerlof, G.A. (1970) The Market for 'Lemons': Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics* 84(3):488-500
- Albrecht, J. (1998) Environmental regulation, comparative advantage and the Porter Hypothesis. University of Ghent. <http://www.feem.it/web/activ/wp/abs98/59-98.pdf>, accessed 12.10.2001.
- Alkhafaji, A.F. (1989) *A Stakeholder Approach to Corporate Governance*. Quorum Press, New York.
- Allen, P. (1994) Evolutionary Complex Systems: Models of Technology Change. In: L. Leydesdorff and P. van den Besselaar (eds.) *Evolutionary Economics and Chaos Theory: New Directions in Technology Studies*, pps. 1-18. Pinter, London.
- Alvesson, I.M. and Berg, P.O. (1992) *Corporate Culture and Organisational Symbolism: An Overview*. De Gruyter, Berlin.
- Ananda, J. and Herath, G. (2002) Assessment of wilderness quality using the analytical hierarchy process. *Tourism Economics* 8(2):189-206.
- Andersen, M., (1998). A theory of interorganisational green learning: An Industrial Dynamic approach. Paper to the Greening of Industry Network Conference, Rome, 15-18 Nov 1998.
- Andrews, K.R. (1987) *The Concept of Corporate Strategy*. Irwin Press, Illinois.
- Angell, L.C. (1998) Toward a Process Framework of Environmental Change: A Guide for Empirical Research into the Formulation and Implementation of Environmental Change in SME vs. Large Manufacturing Facilities. Paper to the Greening of Industry Network Conference, Rome, 15-18 November 1998.
- Ansoff, I. (1965) *Corporate Strategy*. McGraw Hill, New York.
- Appleton, A.E. (1999) Shrimp/Turtle: Untangling the Nets. *Journal of International Economic Law* 2(3):447-496.
- Argyris, C. (1964) *Integrating the Individual and the Organisation*. John Wiley, New York.
- Arrow, K.J. (1994) Information and the Organisation of Industry. Occasional Paper, *Rivista Internazionale Di Scienze Sociali*.

- Atkinson, G. (2000) Measuring corporate sustainability. *Journal of Environmental Planning and Management* 43(2):235-252
- Arthur, W.B. (1989) Competing Technologies, Increasing Returns, and Lock-In by Historical Events. *The Economic Journal* 99:116-131.
- Arthur, W.B. (1990) Positive Feedbacks in the Economy. *Scientific American* 262:92-99.
- Arthur, W.B. (1994) *Increasing Returns and Path Dependence in the Economy*. The University of Michigan Press, Ann Arbor.
- Arthur, W.B., Ermoliev, Y.M. and Kaniovski, Y.M. (1987) Path dependence processes and the emergence of macro-structures. *European Journal of Operational Research* 30:294-303.
- Atkinson, G. (2000) Measuring Corporate Sustainability. *Journal of Environmental Planning and Management* 43(2):235-252.
- Axelrod, R. (1984) *The Evolution of Cooperation*. Basic Books, New York.
- Badaracco, J.L. (1991) The Boundaries of the Firm. in Etzioni, A. and Lawrence, P.R.(Eds) *Socio-Economics. Towards a New Synthesis*. M.E.Sharp, London.
- Baldassare, M. and Katz, C., (1992) The personal threat of environmental problems as predictor of environmental practices. *Environment and Behaviour* 5:602-616.
- Barrett, J., Cherrett, N., Birch, R. and Simmons, C., (2004) An analysis of the policy and educational application of the ecological footprint. A report to WWF Scotland by the Stockholm Environment Institute–York and Best Foot Forward. <http://www.wwf.org.uk/filelibrary/pdf/analysisfootprint.pdf>, accessed 22.10.2006.
- Bebbington, J. and Thomson, I. (1996) *Business conceptions of sustainability and implications for accountancy*. Certified Accountants Educational Trust, London.
- Becker, G.S. (1976) *The Economic Approach to Human Behaviour*. University of Chicago Press, Chicago.
- Bennett, M. and James, P. (1999) (Eds.) *Sustainable measures: evaluation and reporting of environmental and social performance*. Greenleaf, Sheffield, UK.
- Bentham, J. (1776/1789) *An Introduction to the Principles of Morals and Legislation*. Athlone Press, London.
- van den Bergh, J.C.J.M. (2003) Evolutionary analysis of the relationship between economic growth, environmental quality and resource scarcity. In: Ayres, R., Simpson, D and Toman, M. (Eds) *Scarcity and Growth in the New Millennium*. Resources for the Future, Washington D.C.
- Birchard, B. (2000) Letters From the Social Reporting Front. *Tomorrow*. July/August: 56-58.
- Bjorner, T.B., Hansen, L.G. and Russell, C.S. (2004) Environmental labeling and consumers' choice—an empirical analysis of the Nordic Swan. *Journal of Environmental Economics and Management* 47:411-434

- Black, J.S. and Stern, P.C. (1985) Personal and contextual influences on household energy adaptations. *Journal of Applied Psychology* 70(1):3-21.
- Blamey, R. and Bennett, J. (2001) Yea-saying and validation of a choice model of green product choice. In: Bennett, J. and Blamey, R. (Eds.) *The Choice Modelling Approach to Environmental Valuation*. Edward Elgar, Cheltenham.
- Blaza, A.J. (1992) Environmental Reporting - a View from the CBI. In Owen, D.(Ed) *Accounting and the Challenge of the Nineties*. Chapman & Hall, London.
- Bohringer, C. and Jochem, P.E.P. (2007) Measuring the immeasurable – A survey of sustainability indices. *Ecological Economics* 63(1):1-8.
- Borgida, E. and Campbell, B., (1982). Belief relevance and attitude-behaviour consistency: the moderating role of personal experience. *Journal of Personality and Social Psychology* 2:239-247.
- Bouazzaoui, I.E., Gondran, N. and Bourgois, J. (2007) Ecological Footprint at a Small Scale: Proposition of a Method and Model of Representation of Ecological Footprint for Industrial Activities. Conference paper presented at ‘The International Ecological Footprint Conference’, 8-12 May 2007, Cardiff, UK.
- Bougherara, D., Grolleau, G., and Thiebaut, L. (2005) Can Labelling Policies Do More Harm Than Good? An Analysis Applied to Environmental Labelling Schemes. *European Journal of Law and Economics* 19:5-16.
- Boulding, K.E. (1970) *A Primer on Social Dynamics*. Free Press, New York.
- Bouma, J.J. and Wolters, T. (1998) *Management accounting and environmental management: A survey among 84 European companies*. Erasmus Centre for Environmental Studies, Rotterdam.
- Bowie, N.E. (1991) The Firm as a Moral Community. In: Coughlin, R.M. (Ed) *Morality, Rationality and Efficiency. New Perspectives on Socio-Economics*. M.E.Sharpe, London.
- Bryant, C. and Cook, P. (1992) Attitudes, accounts and impact assessment. *Sociological Review* 43:100-122.
- Burnside, A. (1990) Keen on green. *Marketing*, 17 May.
- Cairncross, F. (1992) *Costing the earth*. Harvard University Press, Cambridge.
- Callenbach, E., Capra, F., Goldman, L., Lutz, R. and Marburg, S. (1993) *EcoManagement: The Elmwood Guide to Ecological Auditing and Sustainable Business*. Adamantine, Twickenham, UK.
- Callens, I. and Tyteca, D. (1999) Towards indicators of sustainable development for firms. A productive efficiency perspective. *Ecological Economics* 28:41-53.
- Chandler, A.D. (1986) The Evolution of Modern Global Competition. In: Porter, M.E. *Competition in Global Industries*. Harvard Business School Press, Cambridge.

- Canadian Institute of Chartered Accountants [CICA] (1997) *Full cost accounting from an environmental perspective*. Canadian Institute of Chartered Accountants, Toronto.
- Chen, B., Chen, G.Q., Yang, Z.F. and Jiang, M.M. (2007) Ecological footprint accounting for energy and resource in China. *Energy Policy* 35:1599-1609.
- CICA (1997) *Full Cost Accounting from an Environmental Perspective*. Canadian Institute of Chartered Accountants, Toronto.
- Clarkson, M.E.B. (1991) The Moral Dimension of Corporate Social responsibility. In: Coughlin, R.M. (Ed) *Morality, Rationality and Efficiency: New perspectives on Socio-Economics*. M.E.Sharpe, London.
- Coase, R.H. (1937) The Nature of the Firm. *Economica*:386-405.
- Coddington, W. (1993) *Environmental Marketing: Positive Strategies for Reaching the Green Consumer*. McGraw-Hill, New York.
- Colby, M.E. (1991) Environmental management in development: The evolution of paradigms. *Ecological Economics* 3:193-213.
- Corrigan, K. (1989) They've got to be green. *Marketing News*, 15 October:74.
- Coughlin, R.M. (Ed) (1990) *Morality, Rationality and Efficiency: New perspectives on Socio-Economics*. M.E.Sharpe, London.
- Cowell, F.A. (1986) *Microeconomic Principles*. Philip Allan, Oxford.
- Daly, H.E. (1971) Towards a Stationary-State Economy. In Harte, J. and Socolow, R. *Patient Earth*. Holt, Rinehart & Winston, New York.
- Daly, H.E. (1992) *Steady State Economics*. Earthscan, London.
- Daly, H.E. and Cobb, J.B. (1989) *For the Common Good. Redirecting the Economy towards Community, the Environment and a Sustainable Future*. Green Print, London.
- David, P.A. (1975) *Technical choice, innovation and economic growth*. Cambridge University Press, Cambridge.
- David, P.A. (1985) Clio and the Economics of QWERTY. *American Economic Review* 76:332-337.
- David, P.A. (1986) Understanding the Economics of QWERTY: The Necessity of History. In: Parker, W.N. (Ed) *Economic history and the modern economist*. Basil Blackwell, New York.
- David, P.A. (1993) Path Dependence and Predictability in Dynamic Systems with local Network Externalities: A Paradigm for Historical Economics. In: Foray, D. and Freeman, C. (Eds) *Technology and the wealth of nations: The dynamics of contracted advantage*, pps 208-231. Pinter Publishers, London.
- Davis, J. (1991) *Greening Business: Managing for Sustainable Development*. Basil Blackwell, Oxford.

- Davis, K. (1983) An Expanded View of the Social Responsibility of Business. In: Beauchamp, T.L. and Bowie, N.E. (Eds) *Ethical Theory and Business*, Englewood Cliffs, New York.
- Dietz, S. and Neumayer, E., (2007) Weak and strong sustainability in the SEDA: Concepts and measurement. *Ecological Economics* 61(4):617-626.
- Dodgson, J., Spackman, M., Pearman, A., and Phillips, L. (2001) *Multi-criteria Analysis: A Manual*. Department of the Environment, Transport and the Regions, London.
- Dosi, C. and Moretto, M. (1998) Is Ecolabelling a Reliable Environmental Policy Measure? *Environmental and Resource Economics* 18:113-127.
- DTLR (2001) *DTLR Multi-Criteria Analysis Manual*. Office of the Deputy Prime Minister, London.
- EC (1984) *The Community's Pharmaceutical Industry*. Office for Official Publications of the European Communities, Luxembourg.
- EC (1997) *The Single Market Review. Impact on Manufacturing. Pharmaceutical Products. Subseries 1, Volume 2*. Office for Official Publications of the European Communities, Luxembourg.
- Edwards-Jones, G., Davies, B.D. and Hussain, S.S. (2000) *Ecological Economics: An Introduction*. Basil Blackwell, London.
- Ehrlich, P.R. and Holden J.P. (1971) Impact of population growth. *Science* 171:1212-1217.
- Elkington, J. (1987) *The Green Capitalists: Industry's Search for Environmental Excellence*. Victor Gollancz, London.
- Elster, J. (1985) *The Multiple Self*. Cambridge University Press, Cambridge.
- Engel, J.R. (1990) The Ethics of Sustainable Development. In: Engel, J.R. and Engel, J.G. (Eds) *Ethics of Environment and Development: Global Challenge, International Responses*. Belhaven, London.
- ENDS (1999) UK chemical industry urges energy tax rebate. *ENDS daily* 27 May 1999.
- Environmental Protection Authority [EPA] (1993) *Status report on the use of Environmental Labels Worldwide*. Report prepared by Abt Associates for the US Environmental Protection Agency, Washington D.C.
- Environmental Protection Authority [EPA] (1998) *Environmental labelling issues, policies and practices worldwide*. Office of Prevention, Pesticides and Toxic Substances, United States EPA.
- Etzioni, A. (1988) *The Moral Dimension: Toward a New Economics*. Free Press, New York.
- Etzioni, A. (1991) Liberals, Communitarians, and Choice. In Etzioni, A. and Lawrence, P.R. (Eds) *Socio-Economic: Towards a New Synthesis*. M.E.Sharpe, London.
- Fare, R., Grosskopf, S. and Tyteca, D. (1996) An activity analysis model of the environmental performance of firms: Application to fossil fuel-fired electric utilities. *Ecological Economics* 18:161-175.

- Farmer, M and Randall, A. (1998) The rationality of a safe minimum standard. *Land Economics* 74:287-302.
- Farrow, S. and Toman, M. (1999) Using benefit-cost analysis to improve environmental regulations. *Environment* 41(2):1-12.
- Feindt, P.H. (2000) Die soziale Dimension in der Nachhaltigkeit und das Konzept des Sozialkapitals. *Zeitschrift für angewandte Umweltforschung* 13: 483–492.
- Figge, F and Hahn, T. (2004) Sustainable Value Added – measuring corporate contributions to sustainability beyond eco-efficiency. *Ecological Economics* 48(2):173-187.
- Figge, F., Hahn, T. and Barkemeyer R. (2008) *Sustainable Value in Automobile Manufacturing*. Queen's University, Belfast.
- Foran, B., Lenzen, M., Dey, C. and Bilek, M., (2005) Integrating sustainable chain management with triple bottom line accounting. *Ecological Economics* 52(2):143-157.
- Fox, M.A. and Singh, M. (1997) Life Cycle Management: Status of Concepts and Techniques. *Proceeding of the 1997 Total Life Cycle Conference – Life Cycle Management and Assessment*. SEA:1-7.
- Freeman, R.E. (1984) *Strategic Management : a Stakeholder Approach*. Pitman, Marshfield.
- Friedlander, S.K. (1989) Environmental issues: implication for engineering design and education. In: Ausubel, J.H. and Sladovich, H.E. (eds.) *Technology and Environment*. National Academy Press, Washington.
- Friedman, M. (1963) *Capitalism and Freedom*. Phoenix Books, Chicago.
- Friedman, M. (1970) The social responsibility of business to increase its profits. *The New York Times Magazine*, September 13, 1970.
- Friends of the Earth (1991) *Green Con of the Year Awards 1991*. Press Release, 19 December.
- Galambos, L. and Sturchio, J.L. (1998) Pharmaceutical firms and the transition to biotechnology: A study in strategic innovation. *Business History Review* 72:250-278.
- Gebhardt, M. (1998) Sustainable use of biodiversity by the pharmaceutical industry? *International Journal of Sustainable Development* 1(1):63-72.
- George, C. and Dias, S., (2005) Sustainable Consumption and Production – Development of an Evidence Base. Study of Ecological Footprinting. Report prepared for the Department for Environment, Food and Rural Affairs (DEFRA) by Risk and Policy Analysts Limited, Norfolk.
- Georgescu-Roegen, N. (1971) *The Entropy Law and the Economic Process*. Harvard University Press, Cambridge.
- Gibbons, R., (1992) *A Primer in Game Theory*. Harvester Wheatsheaf., London.
- Global Reporting Initiative [GRI] (2006) *Sustainability Reporting Guidelines*. Coalition for Environmentally Responsible Economies [CERES], Boston.

- Golombek, R. and Raknerud, A. (1997) Do environmental standards harm manufacturing employment? *Scandinavian Journal of Economics* 99:29-44.
- Goodland, R. (1992) The case that the world has reached its limits. In: Goodland, R., Daly, H.E., Serafy, S.E., and von Droste, B. (Eds) *Environmentally Sustainable Economic Development: Building on Brundtland*. UNESCO, Paris.
- Gore, A. (1992) *Earth in the Balance*. Houghton Mifflin Co, Boston.
- Gowdy, J. (1994) *Coevolutionary Economics: The Economy, Society and the Environment*. Kluwer Academic Publishers, Boston.
- Granovetter (1991) *Socio-economics: Towards a New Synthesis*. Armonk, New York.
- Gray, R. (1990) *The Greening of Accountancy: the Profession after Peace*. Institute of Chartered Accountants of England and Wales, London.
- Gray, R., Bebbington, J. and Walters, D. A (1993) *Accounting for the Environment*. Chapman, London.
- Gray, R.H. and Milne, M.J. (2004) Towards Reporting On The Triple Bottom Line: Mirages, Methods and Myths. In Henriques, A. and Richardson, J. (Eds.) *The Triple Bottom Line: Does it All Add Up?* Earthscan, London.
- Grote, U. and Deblitz, C. (2000) Towards quantifying the cost of environmental standards: case study results from selected agricultural products. <http://idpm.man.ac.uk/isdu/grote.pdf>, accessed 12.10.2007.
- Hanley, N. (2000) Macroeconomic measures of sustainability. *Journal of Economic Surveys* 14:1-30.
- Hanley, N. and Folmer, H. (Eds) (1998) *Game Theory and the Environment*. Edward Elgar, Cheltenham, UK.
- Hardin, G. (1968) The Tragedy of the Commons. *Science* 162:1243-48.
- Hassam, B.H. (1978). The search for the best alternative using multiple criteria; Singapore transit study. *Economic Geography* 54(3):245-253.
- Hawken, P. and Wackernagel, M. (2000) *Satisfying Lives for All Within the Means of Nature: How a Honed GRI Could Advance True Sustainability*. GRI/CERES, Boston.
- Haynes, K.E., Ratick, S., Cummings-Saxton, J. (1994) Towards a pollution abatement monitoring policy: Measurements, models, mechanics and data requirements. *Environmental Professional* 16:292-303.
- Henion, K.E. (1972) The effects of ecologically relevant information of detergent sales. *Journal of Marketing Research* 9(1):10-14.
- Henion, K.E., Gregory, R. and Clee, A.M. (1980) Trade-offs in attribute levels made by ecologically concerned and unconcerned consumers when buying detergents. *Advances in Consumer Research* 8:624-629.

- Herberger, A.R. and Buchanon, I.D. (1971) The impact of concern for ecological factors on consumer attitudes and buying behaviour. *American Marketing Association Proceedings*: 644-646.
- Heyes, A.G. (1998) Making things stick: Enforcement and compliance. *Oxford Review of Economic Policy* 14(4):50-63.
- Heyes, A.G. and Liston-Heyes, C. (1999) Corporate Lobbying, regulatory conduct and the Porter hypothesis. *Environmental and Resource Economics* 13(2):209-218.
- Hicks, J. (1932) *The theory of wages*. Macmillan, London.
- Hicks, J. (1946) *Value and capital: an inquiry into some fundamental principles of economic theory* (2nd Edition). Clarendon Press, Oxford.
- Hillman, M. (2004) *How we can save the planet*. Penguin, London.
- Hirsch, F. (1976) *The Social Limits to Growth*. Harvard University Press, Cambridge.
- Holland, L. (2003) Can the principle of the ecological footprint be applied to measure the environmental sustainability of business? *Corporate Social Responsibility and Environmental Management* 10:224-232.
- Howard J.A. and Sheth J.N. (1969) *The Theory of Buyer Behavior*. John Wiley and Sons, New York.
- Hukkinen, J. (2001) Eco-efficiency as abandonment of nature. *Ecological Economics* 38(3):311-315.
- Hunt, C.B. and Auster, E.R. (1990) Proactive Environmental Management: Avoiding the Toxic Trap. *Sloan Management Review* 31(2):7-18.
- Hussain, S.S. (1999) The ethics of 'going green': the corporate social responsibility debate. *Business Strategy and the Environment* 8(4):203-210.
- Hussain, S.S. (2000) Green consumerism and eco-labelling: a strategic behavioural model. *Journal of Agricultural Economics* 51(1):77-89.
- Hussain, S.S. (2003) Eco-innovations and industrial organisation: a review of complementary explanations of unsustainable economic paths. *International Journal of Agricultural Resources, Governance and Ecology* 2:243-261.
- Hussain, S.S. and Lim, D. (2000) The Development of Eco-Labeling Schemes: an Economic Perspective. In: Madu, C. N. (Ed.) *Handbook of Environmentally-Conscious Manufacturing*, pps. 171-189. Kluwer Academic, London.
- Hussain, S.S. and Moran, D. (2005) *Analysis of the contexts in which alternatives to traditional regulation could work efficiently and effectively to improve food safety and standards*. Final report to the Food Standards Agency.
- Hussain, S.S., Halpin, L. and McVittie, A. (2006) The economic viability of Environmental Management Systems: an application of Analytical Hierarchy Process to rank trade-

offs. *Proceedings of the Corporate Responsibility Research conference, Trinity College Dublin, 4-5 September 2006.*

- Ibanez, L. and Grolleau (2008) Can Ecolabeling Schemes Preserve the Environment? *Environmental and Resource Economics* 40:233-249.
- ICCA (International Council for Chemical Associations) (1999) *Responsible Care Status Report 1998*. <http://www.icca-chem.org/>, accessed 07/05/2006.
- Irwin, A. and Vergragt, P. (1991) Environmental issues as threats and opportunities for technological innovation: the social negotiation of technical change. *Technology Analysis and Strategic Management* 1:57-70.
- IUCN (1980) *World Conservation Strategy: Living Resources Conservation for Sustainable Development*. IUCN, Gland, Switzerland.
- IUCN (1991) *Caring for the Earth: A Strategy for Sustainable Living*. IUCN, Gland, Switzerland.
- Iyer, E. and Banerjee, B. (1993) Anatomy of green advertising. In: McAlister, L. and Rothschild, M. (Eds) *Advances in Consumer Research*: 292-298. Association for Consumer Research, Provo, UT.
- Jacobs, P. and Munro, D.A. (1987) *Conservation with Equity: Proceedings of the Conference on Conservation and Development – Implementing the World Conservation Union Strategy, Ottawa, 31 May – 5 June 1986*. IUCN, Cambridge, UK.
- Jacobsson, N. and Jonsson, K. (1999) Feasibility Study of Equivalence of Eco-labelling Criteria. *International Institute for Industrial Environmental Economics at Lund University, IIIEE Research Report 1999:1*.
- Jaffe, A.B., Peterson, S.R., Portney, P.R. and Stavins, R.N. (1995) Environmental regulation and the competitiveness of US manufacturing: What does the evidence tell us? *Journal of Economic Literature* 33:132-161.
- James, B. (1990) *The global pharmaceuticals industry in the 1990s: the challenge of change*. The Economist Intelligence Unit, Special Report 2071. The Economist, London.
- Johansson, O. (1995) Optimal Pigovian taxes under altruism. *Land Economics* 73:297-308.
- Kamenetzky, (1992) The economics of the satisfaction of needs. In: Ekins, P. and Max-Neef, M. (Eds.) *Real Life Economics*, pps 181-196. Routledge, London.
- Karl, H. and Orwat, C. (1999) Economic aspects of environmental labelling. In: Folmer, H. and Tietenberg, T. (Eds.) *The International Yearbook of Environmental and Resource Economics 1999/2000*, pps. 107-170. Edward Elgar, Cheltenham, UK.
- Kennedy, C. (1964) Induced Bias in Innovation and the Theory of Distribution. *The Economic Journal* 74:541-547.

- Kerin, A.R. and Peterson, R.A. (1974) Selected insights of ecologically responsible behaviour. *American Institute for Decision Sciences Proceedings* 6:33.
- Klein, N. (2002) *No logo*. Picador, New York.
- Kok, G. and Siero, S. (1985) Tin recycling: awareness, comprehension, attitude, intention and behaviour. *Journal of Economic Psychology* 6(2):157-173.
- Kolk, A. (2000) *Economics of Environmental Management*. Pearson Education Limited, Harlow, UK.
- Korten, D.C. (1995) *When Corporations Rule the World*. Earthscan, London.
- Kitzes, J., Peller, A., Goldfinger, S. and Wackernagel, M. (2007) Current methods for Calculating National Ecological Footprint Accounts. *Science for Environment and Sustainable Society* 4(1):1-9.
- KPMG (1999) *Environmental Reporting in the Pharmaceuticals Industry*. KPMG Environmental Services, Finland.
- Kula, E. (1998) *History of Environmental Economic Thought*. Routledge, London.
- Kuhre W.L. (1997) *ISO 14020s Environmental Labelling and Marketing*. Prentice Hall, New Jersey.
- Kusterer, M. and Hussain, S.S. (2001) The role of corporate sustainability indicators in the eco-innovation process: an empirical investigation of the process of change in the pharmaceutical industry. *Business Strategy and the Environment* 10(5):300-314.
- Lahaye, N. and Llerena, D. (1996) Technology and Sustainability: An Organisational and Institutional Change. In: Faucheaux, S., Pearce, D. and Proops, J. (Eds) *Models of Sustainable Development*. Edward Elgar, Cheltenham, UK.
- Lancaster, K.J. (1966) A new approach to consumer theory. *Journal of Political Economy* 74:132-157.
- Lancaster, K.J. (1971) *Consumer demand: a new approach*. Columbia University Press, New York.
- Ledgerwood, G., Street, E. and Therivel R. (1993) *The Environmental Audit and Business Strategy. A Total Quality Approach*. Pitman, London.
- Lenzen, M., Lundie, S., Bansgrove, G., Cheret, L. and Jack, F. (2002) A novel Ecological Footprint and an example application. The University of Sydney, Sydney, Australia. <http://www.isa.org.usyd.edu.au/publications/documents/SydneyWaterFootprint.pdf>, accessed 10.07.2008.
- Lenzen, M. and Murray, S.A., (2003) The Ecological Footprint – Issues and Trends. The University of Sydney, Sydney, Australia, http://www.isa.org.usyd.edu.au/publications/documents/Ecological_Footprint_Issues_and_Trends.pdf, accessed 10.07.2008.

- Lenzen, M., Hansson, C.B. and Bond, S., (2007). On the bioproductivity and land-disturbance metrics of the Ecological Footprint. *Ecological Economics* 61(1):6-10.
- Leontieff, W. (1982) Academic Economics. *Science* 217 (July 9):104-105.
- Leopold, A. (1949) *A Sand County Almanac*. Oxford University Press, Oxford.
- Levitt, T. (1983) The Dangers of Social Responsibility. In: Beauchamp, T.L. and Bowie, N.E. (Eds) *Ethical Theory and Business*. Englewood Cliffs, New Jersey.
- Lucas, R.E. Jr. (1967) Tests of Capital-Theoretical Model of Technological Change. *Review of Economic Studies* 34:175-180.
- Lundberg, C.C. (1989) On organizational learning: Implications and opportunities for expanding organizational development. *Research in Organizational Change and Development* 3:61-82.
- Lundvall, B.-Å. (1992) *National Systems of Innovation*. Pinter, London.
- Machiavelli (1500/1513) *The Prince and the discourses*. Random House, New York.
- MacLeod, M., Moran, D., Oosterhuis, F. Hussain, S.S. and Bevan, K. (2009) *The Origins and Appraisal of Regulation*. In: MacLeod, M., Ekins, P., Moran, D. and Vanner, R. (Eds) *Understanding the Costs of Environmental Regulation in Europe*. Cheltenham: Edward Elgar.
- Mallmann, C.A. (1973) On the satisfaction of human aspirations s the development objective. Paper presented at the Symposium of Science, Technology and Human Values, Mexico City, 2-3 July.
- Management Consultancy (1989) Keep your head in the green revolution. September:56-57.
- Marshall, A. (1920) *Principles of Economics*. Macmillan, London.
- Martinez-Alier, J. (2004) *The Environmentalism of the Poor: A study of ecological conflicts and valuation*. Edward-Elgar, Cheltenham, UK.
- Maslow, A. (1954) *Motivation and Personality*. Harper Brothers, New York.
- Mayer, A.L. (2008) Strengths and weaknesses of common sustainability indices for multidimensional systems. *Environment International* 34: 277-291.
- Mayer, A.L., Thurston, H.W., and Pawlowski, C.W. (2004) The multidisciplinary influence of common sustainability indices. *Frontiers in Ecology and Environment* 2:418-246.
- Max-Neef, M. (1992) Development and human needs. In: *Real Life Economics* (Eds. Ekins, P. And Max-Neef, M. pps 197-213. Routledge, London.
- McCormick, J. (1991) *British Politics and the Environment*. Earthscan, London.
- Meadows, D. H., Meadows, D.L., Randers, J. , and Behrens, W.W., (1972) *The Limits to growth. A report for the Club of Rome's project on the predicament for mankind*. Universe Books, New York.
- Meadows, D.H., Meadows, D.L. and Randers, J. (1992) *Beyond the Limits. Global Collapse or a Sustainable Future*. Earthscan, London.

- Meredith, S. and Wolters, T. (1996) Technological innovations as answers to environmental problems: the role of networks and alliances within the Dutch and UK paint industry. *Greener Management International* 1996: 92-107.
- Metcalf, S. and Diliso, N. (1996) Innovation, Capabilities and Knowledge: the Epistemic Connection. In: J. de la Mothe and G. Paquet (Eds.) *Evolutionary Economics and the New International Political Economy*, pps.58-79. Pinter, London.
- Milgrom, P. and Roberts, J. (1992) *Economics, Organisation and Management*. Prentice-Hall, Englewood Cliffs.
- Milne, M.J., Ball, A. and Gray, R. (2008) Wither Ecology? The Triple Bottom Line, The Global Reporting Initiative and the Institutionalization of Sustainable Development Reporting.: *American Accounting Association Annual Meeting, 3-6 Aug 2008, Anaheim, CA, USA*.
- Moffatt, I., (2000) Ecological footprints and sustainable development. *Ecological Economics* 32:359-362.
- Moffatt, I., Hanley, N., Allen, S. and Fundingsland, M. (2001) *Sustainable Prosperity: Measuring Resource Efficiency*. Report prepared for the Department of the Environment, Transport and the Regions.
- Mohr, R.,D. (2002) Technical change, external economies and the Porter Hypothesis. *Journal of Economics and Management* 43:158-168.
- Morhardt, J.E. (2001): Scoring Corporate Environmental Reports for Comprehensiveness: A Comparison of Three Systems. *Environmental Management* 26(6):881-892.
- Morhardt, J.E., Baird, S., and Freeman, K. (2002) Scoring corporate environmental and sustainability reports using GRI 2000, ISO 14031, and other criteria. *Corporate Social Responsibility and Environmental Management* 9:215-233.
- de la Mothe, J. and Paquet, G. (1996) *Evolutionary Economics and the New International Political Economy*. Pinter, London.
- Mowery, D.C. and Rosenburg, N. (1979) The Influence of Market Demand Upon Innovation: A Critical Review of Some Recent Empirical Studies. *Research Policy* 8:103-153.
- Murphy, O. (1989) Green is the colour. *Survey* (Winter):9-11.
- Nelson, P. (1970) Information and consumer behaviour. *Journal of Political Economy* 78:311-329.
- Nelson, R.R. and Winter, S.G. (1973) Toward an Evolutionary Theory of Economic Capabilities. *American Economic Review* 63:440-449.
- Nelson, R.R. and Winter, S.G. (1974) Neoclassical vs. Evolutionary Theories of Economic Growth: Critique and Prospects. *Economic Journal* 84:886-905.

- Nelson, R.R. and Winter, S.G. (1975) Factor Price Changes and Factor Substitution in an Evolutionary Model. *Bell Journal of Economics* 6:466-486.
- Nelson, R.R. and Winter, S.G. (1977) Simulation of Schumpeterian Competition. *American Economic Review* 67:271-276.
- Nelson, R.R. and Winter, S.G. (1982) *An evolutionary theory of economic change*. Harvard University Press, Cambridge, MA.
- Nelson, R.R., Winter, S.G. and Schuette, H.L. (1976) Technical Change in an Evolutionary Model. *Quarterly Journal of Economics* 40:90-118.
- Nguyen, H.X. and Yamamoto, R., (2007) Modification of ecological footprint evaluation method to include non-renewable resource consumption using thermodynamic approach. *Resources, Conservation and Recycling* 51(4):870-884.
- Nimon, W. and Beghin, J. (1999) Are eco-labels valuable? Evidence from the apparel industry. *American Journal of Agricultural Economics* 81(4):801-811.
- Norgaard, R.B. (1994) *Development Betrayed*. Routledge, London.
- North, K. (1992) *Environmental Business Management: An Introduction*. International Labour Office, Geneva.
- Nozick, R. (1974) *Anarchy, State and Utopia*. Basic Books, New York.
- Nyborg, K. (2000) Homo Economicus and Homo Politicus: interpretation and aggregation of environmental values. *Journal of Economic Behaviour and Organisation* 42(3):305-322.
- OECD (1991) *Environmental Labelling in OECD Countries*. Organisation for Economic Cooperation and Development, Paris.
- OECD (1997) *Eco-Labelling: Actual Effects of Selected Programmes*. OECD/GD(97)105. Organisation for Economic Cooperation and Development, Paris.
- Oglethorpe, D. , Hanley, N., Hussain, S. and Sanderson, R. (2000) Modelling the transfer of socio-economic benefits of environmental management. *Environmental Modelling and Software* 15(4):343-356.
- Ohmae, K. (1990) *The Borderless World: Power and Strategy in the Interlinked Economy*. Harper Collins, London.
- Olsen, M.E., (1981) Consumers' attitudes toward energy conservation. *Journal of Social Issues* 3:111-136.
- Ostrom, E., Gardner, R. and Walker, J. (1994) *Rules, Games & Common-Pool Resources*. Michigan University Press, Michigan.
- O'Toole, J. (1985) *Vanguard Management*. Doubleday, New York.
- Palmer, K., Oates, W.E. and Portney, P.R. (1995) Tightening environmental standards: The benefit-cost or the no-cost paradigm. *Journal of Economic Perspectives* 9(4):119-132.

- van Passel, S., Neven, F., Mathijs, E. and Van Huylenbroeck, G. (2007) Measuring farm sustainability and explaining differences in sustainable efficiency. *Ecological Economics* 62:149-161.
- Pearce, D. and Atkinson, G. (1993) Capital theory and the measurement of sustainable development: an indicator of 'weak' sustainability. *Ecological Economics* 8:103-108.
- Pearce, D.W. and Turner, R.K. (1990) *Economics of Natural Resources and the Environment*. Harvester Wheatsheaf, London.
- Peattie, J.K. (1990) Painting marketing education (or how to recycle old ideas). *Journal of Marketing Management* 6(2):105-125.
- Peattie, K. (1992) *Green Marketing*. M&E Handbooks, Pitman Publishing, London.
- Piore, M. and Sable, C. (1984) *The Second Industrial Divide*. Basic Books, New York.
- Porter, M.E. (1990) *The competitive advantage of nations*. Free Press, Illinois.
- Porter, M.E. (1991) America's Green Strategy. *Scientific American* 264:168.
- Porter, M.E. and van der Linde (1995a) Towards a new conception of the environmental-competitiveness relationship. *Journal of Economic Perspectives* 9(4):97-118.
- Porter, M.E. and van der Linde (1995b) Green and competitive - ending the stalemate. *Harvard Business Review on Business and the Environment*:131-167
- Potters, J. and van Winden, F. (1996). Comparative statics of a signalling game: an experimental study. *International Journal of Game Theory* 25:329-353.
- Potters, J. And van Winden, F. (1992) Lobbying and asymmetric information. *Public Choice* 74:269-292.
- Power, M. (1991) Auditing and environmentalism expertise: Between protest and professionalism. *Accounting Auditing and Accountability Journal* 4:30-42.
- Proctor, W., and Drechsler, M. (2001) Deliberative Multi-criteria Evaluation: A case study of recreation and tourism options in Victoria Australia. *Tenerife, European Society for Ecological Economics, Frontiers 2 Conference*.
- Rammel, C. and van den Bergh, C.J.M. (2003) Evolutionary policies for sustainable development: adaptive flexibility and risk minimising. *Ecological Economics* 47:121-133.
- Reid, D. (1997) *Sustainable Development. An Introductory Guide*. Earthscan, London.
- Regner, M. (1992) *Environmental Audit*. The Institute of Chartered Accountants in England and Wales, London.
- Rhenman, E. (1968) *Industrial Democracy and Industrial Management*. Tavistock Publications, London.
- Robertson, P.E. (2003) Eco-labels and Free Riding. *University of New South Wales Discussion Paper, Sydney 2003/9*

- Robins, N. and Trisoglio, A. (1992) Restructuring industry for sustainable development. In: Holmberg, J. (Ed) *Making Development Sustainable*. Island Press, Washington.
- Rockness, J.W. (1985) An Assessment of the Relationship between US Corporate Environmental Performance and Disclosure. *Journal of Business Finance and Accounting* 12(3):339-354.
- Roddick, A. (1992) In search of the Sustainable Business. *Ecodecision*, December 1992:71-73.
- Roediger-Schluga (2001) The stringency of environmental regulation and the Porter Hypothesis. Merit-Infonomics Research Memorandum Series.
http://www.137.120.22.236/www_eddocs/loader/file.asp?id=207, accessed 01/09/2008.
- Roome, N. (1992) Developing Environmental Management Strategies. *Business Strategy and the Environment* 1(1):11-24.
- Rosen, S. (1974) Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economy* 82:34-55.
- Rote Liste Service GmbH (1997) *Rote Liste, 1997*. Edition Cantor Verlag: Aulendorf/Wurt.
- Rutledge, G.L. and Vogan, C.R. (1994) Pollution abatement and control expenditures, 1972-1992. *Survey of Current Business* 74:36-49.
- Ruttan, V.R. (1996) *Sources of technical change: induced innovation, evolutionary theory and path dependence*. Bulletin Number 96-4, Economic Development Center, Department of Economics, University of Minnesota.
- Saaty, T.L. (1980) *The Analytical Hierarchy Process*. McGraw Hill, New York.
- Salter, W.E.G. (1960) *Productivity of Technical Change*. Cambridge University Press, Cambridge.
- Samuelson, P.A. (1965) A Theory of Induced Innovation Along Kennedy-Weizsacher Lines. *Review of Economics and Statistics* 47:343-356.
- Schaefer, A. and Harvey, B. (1997) Stage models of corporate greening: a critical evaluation. *Proceedings of Business Strategy and the Environment conference, 18-19 September 1997, Leeds, UK*.
- Shelton, R., and Shopley, J. (1996) Hitting the green wall. *Perspectives*. Little, Boston, MA.
- Scherer, F.M. (1993) Pricing, Profits and Technological Progress in the Pharmaceutical Industry. *Journal of Economic Perspectives* 7(1): 97-115.
- Schookler, J. (1962) Determinants of Industrial Invention. In: Nelson, R.R. (Ed) *The rate of direction of inventive activity: Economic and social factors*. Princeton University Press, Princeton.
- Schot, J. and Fischer, K. (1993) Introduction: The Greening of the Industrial Firm. in Fischer, K. & Schot, J. (eds) *Environmental Strategies for Industry*. Island Press, Washington.
- Schotter, A. (1981) *Economic Theory of Social Institutions*. Cambridge University Press, Cambridge.

- Schumacher, E.F. (1973) *Small is Beautiful: Economics as if People Mattered*. Harper & Row, New York.
- Schumpeter, J.A. (1934) *The Theory of Economic Development*. Harvard University Press, Cambridge.
- SETAC (1993) *Guidelines for life Cycle Assessment: A 'Code of Practice', Edition 1*. SETAC, Brussels.
- Shim, J.P. (1989) Bibliographical research on the analytical hierarchy process (AHP). *Socio-Economic Planning Science*, 23:161-167.
- Simintiras, A.C., Schlegelmilch, B.B. and Diamantopoulos, A. (1994) 'Greening' the Marketing Mix: A Review of the Literature and an Agenda for Future Research. In: Baker, M.J. (Ed) *Perspectives on Marketing Management*, Vol.4:1-25.
- Simon, H.A. (1955) A Behavioural Model of Rational Choice. *Quarterly Journal of Economics* 69:99-118.
- Simon, H.A. (1959) Theories of Decision Making in Economics. *American Economic Review* 49:253-283.
- Smith, A. (1966/1776) *The Wealth of Nations*. Everyman, London.
- Smith, A. (1982/1760) *The Theory of Moral Sentiments*. (Eds D.D. Raphael and A.L. Macfie.) Liberty Classics, Indianapolis, IA.
- Soler, C., (1996) Ecological friendly buying - theoretical implications of a phenomenological perspective. *Scandinavian Journal of Management* 12(3):275-289.
- Spence, A.M. (1973). Job market signalling. *Quarterly Journal of Economics* 87:355-374.
- Stern, D. (1997) The capital theory approach to sustainability: a critical appraisal. *Journal of Economic Issues* 31:17-20.
- Stigler, G.J. & Becker, G.S. (1977) De Gustibus Non Est Disputandum. *American Economic Review* 67:76-90.
- Stoker, A. (1983) *International case studies in the transfer of pharmaceutical technology to India and Indonesia*. PhD Thesis. Department of Chemical Engineering, University of Edinburgh.
- Suh, S., Lenzen, M., Treloar, G.J., Hondo, H., Horvath, A., Huppes, G., Joliet, O., Klann, O., Krewitt, W., Moriguchi, Y., Munksgaard, J. and Norris, G., (2004) System Boundary Selection in Life-Cycle Inventories Using Hybrid Approaches. *Environment, Science and Technology* 38(3):657 -664.
- Taylor, F.W. (1911) *Principles of Scientific Management*. Norton, New York.
- Teisl, M.F., Roe, B. and Hicks, R.L. (2002) Can eco-labels tune a market? Evidence from dolphin-safe labeling. *Journal of Environmental Economics and Management* 43:339-359.

- Tobey, J.A. (1990) The effects of domestic environmental policies on patterns of world trade: An empirical test. *Kyklos* 43(2):191-209.
- Tomer, J.F. (1992) The human firm in the natural environment: a socio-economic analysis of its behaviour. *Ecological Economics* 6:119-138.
- Turner, R.K., Jeroen, van den Bergh, J.C.J.M., Soderqvist, T., Barendregt, A., van der Straaten, J., Maltby, E. and van Ierland, E.C. (2000) Ecological economic analysis of wetlands: scientific integration for management and policy. *Ecological Economics* 35:7-23.
- UNEP (1991) *Global Environmental Labelling: Invitational Expert Seminar, Lesvos, Greece*. United Nations Environment Programme/IEO Cleaner Production Programme, New York.
- Uyl, D.J.D. (1984) *The New Crusaders. The Corporate Social Responsibility Debate*. The Social Philosophy and Policy Center, Bowling Green State University Press.
- VCI (Verband der Chemischen Industrie e.V.) (1998a) *Sustainable Development*. Association of the German Chemical Industry, Frankfurt.
- VCI (Verband der Chemischen Industrie e.V.) (1998b) *The Chemical Industry 1998: Globalisation and Sustainability, Environmental Goals and Responsibility, Acceptability and Innovations. Annual Report 1998*. Association of the German Chemical Industry, Frankfurt.
- VfA (Verband Forschender Arzneimittelhersteller) (1999) *Unsere Mitglieder, 1999*. Association of research-based pharmaceutical companies. Frankfurt.
- Verfaillie, H.A., and Bidwell, R. (2000) *Measuring eco-efficiency. A guide to reporting company performance*. World Business Council for Sustainable Development, Geneva.
- Vitalis, V. (2002) Private voluntary eco-labels: trade distorting, discriminatory and environmentally disappointing. Background paper for the round table on sustainable development, OECD, Paris, 6 December.
- Volvo (1998) *Environmental Product Declaration Volvo S80 2.9*. PR/PV 981003, Volvo Car Corporation.
- Wackernagel, M. and Rees, W. (1996) *Our Ecological Footprint. Reducing Human Impact on the Earth*. New Society Publishers, Canada.
- Wackernagel, M., Monfreda, C., Moran, D., Wermer, P., Goldfinger, S., Deumling, D., and Murray, M. (2005) *National Footprint and Biocapacity Accounts 2005: The underlying calculation method*. Global Footprint Network, Oakland, CA.
- Walsh, C., O'Regan, B. and Moles, R., (2007) Incorporating Methane into Ecological Footprint Analysis. Conference paper presented at 'The International Ecological Footprint Conference', 8-12 May 2007, Cardiff, UK.
- Welford, R. (1995) *Environmental Strategy and Sustainable Development. The Corporate Challenge for the 21st Century*. Routledge, London.

- Welford, R. and Gouldson, A. (1993) *Environmental Management and Business Strategy*. Pitman, London.
- Wessells, C.R., Johnston, R.J. and Donath, H. (1999) Assessing Consumer Preferences for Ecolabeled Seafood: The Influence of Species, Certifier and Household Attributes. *American Journal of Agricultural Economics* 81:1084-1089.
- Whitehead, A.N. (1925) *Society and the modern world*. Macmillan, New York.
- Wiedmann, T. and Lenzen, M. (2006) Triple-Bottom-Line Accounting of Social, Economic and Environmental Indicators - A New Life-Cycle Software Tool for UK Businesses. Conference paper presented at the 'Third Annual International Sustainable Development Conference', 15-16 November 2006, Perth, UK.
- Wiles, P. and Routh, G. (1984) *Economics in Disarray*. Basil Blackwell, Oxford.
- Williams T.G. (1982) *Consumer Behavior: Fundamentals & Strategies*. New York: West Publishing Company.
- Wilson, J., Tyedmers, P. and Pelot, R. (2007) Contrasting and comparing sustainable development indicator metrics. *Ecological Indicators* 7(2):299-314.
- Winter, S.G. (1984) Schumpeterian Competition in Alternative Technological Regimes. *Journal of Economic Behavior and Organisation* 5:287-320.
- World Commission on Environment and Development [WCED] (1987) *Our Common Future*. Oxford University Press, Oxford.
- World Trade Organisation (1998) *Trade and Environment News Bulletin* TE/023 14 May 1998.
- World Trade Organisation (2002) *WTO Report – Environmental Cooperation and Trade*. <http://www.gdrc.org/sustbiz/wto1.html>, accessed 01/07/2008.
- Xepapadeas, A. And de Zeeuw, A. (1999) Environmental Policy and Competitiveness: The Porter Hypothesis and the Composition of Capital. *Journal of Environmental Economics and Management* 37:165-182.
- Zahedi, F. (1986) The analytical hierarchy process: A Survey of the method and its applications. *Interfaces* 16:96-108.

APPENDIX 1: Analytical Hierarchy Process Survey

1. Nature of the Firm

1. What are your firm's major product lines?
2. Please state the current number of employees.
3. If known, what are the company's current sales?
4. If known, what is the current R&D budget?

5a. Is your firm part of a transnational company?

Yes ____

No ____ (go to 6)

5b. If 'yes' please indicate whether your corporate environmental management strategy is dictated by your parent company

Yes ____

No ____

6. It is assumed that you are an environmental manager or another manager familiar with your firm's environmental management strategy. Within your firm or transnational company, what level do you manage?

Corporate ____ Plant/Site ____

Divisional ____ Other ____ please specify:

II. Your Firm's Environmental Management System

1a. If your firm is based on multiple sites or organizational units, do all sites and organizational units have environmental management systems in place?

Yes ____ since: (go to 2)

No ____

1b. How many sites or organizational units out of the firm's total number have environmental management systems in place?

2. Is the environmental management system certified?

Yes ____ please specify: EMAS ____ since:

ISO 14001 ____ since:

Other ____ since:

No ____

3a. As a result of your firm's environmental management system, does the firm produce an environmental performance report?

Yes ____ since:

No ____ (go to 4)

3b. If 'yes', what is the frequency at which the report is produced?

4a. As a result of your firm's environmental management system, does the firm undergo environmental auditing?

Yes ____ since:

No ____

4b. If 'yes', what is the frequency of environmental audits?

4c. Are the outcomes of such environmental audits distributed internally or externally?

Yes, internally ____ since:

Yes, externally ____ since:

No, neither ____

III. Drivers for the incorporation of an environmental management system into your firm's business plan

In this section we are aiming to determine the nature of the drivers that caused your firm to incorporate an environmental management system into its business plan. We are specifically attempting to identify what was occurring during the time the environmental management system was being developed.

Below are listed several internal or external drivers that might have influenced your firm to look toward an environmental management system in order to manage your firm's environmental impacts. Please indicate how significant you consider these drivers to be in bringing about the inception of an environmental management system by circling the appropriate number.

External/Internal Drivers	Significance in bringing about EMS					
	insignificant			significant		
Change in firm's organizational structure	1	2	3	4	5	6
Change in firm's upper management	1	2	3	4	5	6
Change in firm's location	1	2	3	4	5	6
New technology	1	2	3	4	5	6
New supply challenges (e.g. change in price of transport or materials)	1	2	3	4	5	6
Emergence of new industry niches	1	2	3	4	5	6
New national regulations	1	2	3	4	5	6
New EU regulations	1	2	3	4	5	6
Voluntary agreements with regulators	1	2	3	4	5	6
Increased competition, nationally	1	2	3	4	5	6
Increased competition, internationally	1	2	3	4	5	6
New or changing customer needs, nationally	1	2	3	4	5	6

New or changing customer needs, internationally	1	2	3	4	5	6
Change in suppliers' needs or values	1	2	3	4	5	6
Change in distributors' needs or values	1	2	3	4	5	6
Change in shareholders' need or values	1	2	3	4	5	6
Change in financial service providers needs or values	1	2	3	4	5	6
Change in insurance providers' needs or values	1	2	3	4	5	6
Change in consumers' needs or values	1	2	3	4	5	6
Increased pressure from non-governmental organizations	1	2	3	4	5	6
Increased pressure from local community	1	2	3	4	5	6
Suggestions for improvements or changes from employees	1	2	3	4	5	6
Others:						
_____	1	2	3	4	5	6
_____	1	2	3	4	5	6
_____	1	2	3	4	5	6
_____	1	2	3	4	5	6
_____	1	2	3	4	5	6
_____	1	2	3	4	5	6

IV. Valuation of the Amenities Provided by an Environmental Management System

We want to know more about how you and your firm value the services, amenities, and benefits provided by your firm's environmental management system. These amenities are of the following types:

- 1) Profitability
- 2) Compliance with Legislation
- 3) Competitiveness
- 4) Social
- 5) Environmental

Please use the following comparison scale to rate the relative importance of the characteristics of each of the amenities listed above as well as the relative importance of the amenities themselves. Please remember that this survey is concerned with your firm's EMS and no other management, R&D, or sales management programs. This comparison will help us determine if the motivations of managers or those in charge of a firm's eco-management scheme affect the long-term viability of a firm's EMS.

Comparison Scale

Rating	Explanation of Relative Importance
1	Two characteristics are equally important
2	Between 1 and 3
3	Circled characteristic is slightly more important
4	Between 3 and 5
5	Circled characteristic is moderately more important
6	Between 5 and 7
7	Circled characteristic is much more important
8	Between 7 and 9
9	Highest possible degree of importance for the circled characteristic over the other

Directions:

1. Please circle the characteristic that is more important to you
2. Assign a rating (1-9) that indicate the degree of importance of the circled characteristic over the other characteristic

Rating				
<i>Profitability</i>	Short-term increase in profits	versus	Long-term increase in profits	1-9
	Short-term increase in profits	versus	Increase in production efficiency	1-9
	Long-term increase in profits	versus	Increase in production efficiency	1-9

Rating				
<i>Compliance with Legislation</i>	Compliance with current legislation	versus	Compliance with pending or future legislation	1-9
	Compliance with current legislation	versus	Avoiding fines for non-compliance	1-9
	Compliance with pending or future legislation	versus	Avoiding fines for non-compliance	1-9

Rating				
<i>Competitiveness</i>	Increased competitiveness in present market	versus	Opportunity for products to enter new market niches	1-9
	Increased competitiveness in present market	versus	Improved public perception	1-9
	Opportunity for products to enter new market niches	versus	Improved public perception	1-9

Rating				
<i>Social</i>	Improvement in relations with local community	versus	Improvement in relations with regulators	1-9

Rating				
<i>Environmental</i>	Environmental benefits from decrease in resource use (energy and raw materials)	versus	Environmental benefits from reduced emissions to air and/or water and waste generation	1-9

Rating				
<i>AMENITIES</i>	Profitability	versus	Compliance with Legislation	1-9
	Profitability	versus	Competitiveness	1-9
	Profitability	versus	Social	1-9
	Profitability	versus	Environmental	1-9
	Compliance with Legislation	versus	Competitiveness	1-9
	Compliance with Legislation	versus	Social	1-9
	Compliance with Legislation	versus	Environmental	1-9
	Competitiveness	versus	Social	1-9
	Competitiveness	versus	Environmental	1-9

V. Comments

If you have any comments you would like to make about environmental management systems and their long-term economic and financial viability, please do so below. We are particularly interested to know what barriers to the economic and financial success of your EMS your firm has experienced previously or expects to experience in the future.

THANK YOU FOR YOUR PARTICIPATION

APPENDIX 2 Eco-innovation Adoption Survey

I. THE NATURE OF YOUR FIRM

1) Please indicate your firm's major product lines.

2) Operation in the pharmaceuticals industry might be sub-categorised as raw material production, processing and retail. For your firm, what proportion of your operation falls into each of these categories?

raw material production for pharmaceutical industry:	%
processing of pharmaceuticals:	%
retail of pharmaceuticals:	%

3a) Is your firm part of a transnational company?

Yes ☐

No ☐ (go to 4)

3b) If 'yes' then please indicate whether your corporate environmental strategy is defined by the parent company:

Yes ☐

No ☐

4) We assume you are an environmental manager or any other manager familiar with your firm's environmental strategy and activities. Within your firm or transnational company, what level do you manage?

corporate	<input type="checkbox"/>	plant	<input type="checkbox"/>
divisional	<input type="checkbox"/>	other	<input type="checkbox"/> (please specify)

All the following responses will be analysed with respect to the management level you have designated.

5) Number of employees (at level considered)

1-20	<input type="checkbox"/>	500-5,000	<input type="checkbox"/>
20-100	<input type="checkbox"/>	5,000-10,000	<input type="checkbox"/>
100-250	<input type="checkbox"/>	10,000-50,000	<input type="checkbox"/>
250-500	<input type="checkbox"/>	>50,000	<input type="checkbox"/>

6) Current sales: £

7) R&D spending: £

II 'GREEN INNOVATIONS' IN PLACE

In this section we would like you to tell us which environmental management activities your firm has undertaken or is planning to undertake in the future. We also ask if measuring your firm's environmental and social performance is part of these activities.

1) Environmental management

1a) Is your firm a member of the Chemical Industry's Responsible Care Programme?

Yes ☐ since:

No ☐

1b) Does your firm participate in any voluntary environmental labelling programmes?

Yes ☐ since:

No ☐

If so, please specify the programme and products:

1c) Does your firm have an environmental management system in place in any of its sites or organisational units?

Yes ☐ since:

No ☐ (go to 1f)

1d) Is the environmental management system certified? Please state type and year of first site's/organisational unit's certification.

Yes ☐ please specify: EMAS ☐ since:

ISO 14001 ☐ since:

Other ☐ since:

No ☐ _____

1e) How many of your company's organisational units or sites have a certified environmental management system in place? Please state number and proportion of total sites/units.

Number of certified sites/organisational units:

Percentage of certified sites/organisational units: %

1f) Does your firm's environmental and/or social activities include any of the following tools and procedures?

Environmental reporting	yes <input type="checkbox"/>	since:	no <input type="checkbox"/>
Environmental auditing	yes <input type="checkbox"/>	since:	no <input type="checkbox"/>
Environmental management Accounting	yes <input type="checkbox"/>	since:	no <input type="checkbox"/>
Life cycle assessment	yes <input type="checkbox"/>	since:	no <input type="checkbox"/>
Social auditing	yes <input type="checkbox"/>	since:	no <input type="checkbox"/>
Social reporting	yes <input type="checkbox"/>	since:	no <input type="checkbox"/>

If you would like to add to this list please do so:

1f) If your firm conducts life cycle assessments, are the results used for product changes and new product development?

Yes ☐ since:

No ☐

1g) If your firm conducts environmental and/or social audits, are the outcomes distributed internally or externally?

Yes, internally ☐ since:

Yes, externally ☐ since:

No to both ☐

2) Measuring environmental and social performance

2a) When monitoring environmental and social performance, does your firm use indicators that are specifically developed for this purpose (e.g. total energy consumption per year in the production process)?

Yes since:

No (go to 2c)

2b) We would like to identify for the following areas whether your firm uses indicators (qualitative or quantitative) to measure its environmental/social performance.

We would like to know if quantitative and time-related targets are established (e.g. reduction in energy consumption in the production process from 75,000 MWh to 50,000 MWh by the end of 2001)

	qualitative indicators	quantitative indicators	targets established
Resource use and emissions/discharges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Assessment of production lines and processes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Major impacts associated with the life cycle of products and services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If you feel this list is not complete and you use indicators in other areas, please specify:

	qualitative indicators	quantitative indicators	targets established
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2c) Is your firm planning to increase its environmental and social measurement activities in the future?

Yes ☐

No ☐ (go to section III)

2d) If so, is your firm planning to use indicators in any of the following areas/

Major <i>environmental</i> impacts associated with the life cycle of products and services	<input type="checkbox"/>	already in place	<input type="checkbox"/>
Major <i>social</i> impacts associated with the life cycle of products and services	<input type="checkbox"/>	already in place	<input type="checkbox"/>
Contribution to climate change	<input type="checkbox"/>	already in place	<input type="checkbox"/>
Impact on biodiversity	<input type="checkbox"/>	already in place	<input type="checkbox"/>
Stakeholder relationships	<input type="checkbox"/>	already in place	<input type="checkbox"/>
Human rights	<input type="checkbox"/>	already in place	<input type="checkbox"/>
Impact on animal welfare	<input type="checkbox"/>	already in place	<input type="checkbox"/>
Other	<input type="checkbox"/>	already in place	<input type="checkbox"/>

Could you please specify some of the other indicators you are planning to use:

III) THE TIMING OF 'GREEN INNOVATIONS'

In this section, we would like to find out about the circumstances and the nature of the changes in your firm's practices towards the environment and/or society. We are asking about what was going on (inside and/or outside the firm) at the time of a particular 'eco-change' (e.g. the installation of pollution prevention measures or the creation of an environmental management division).

1) Please outline the most significant 'eco-change' for your firm and specify the time or time period when it occurred:

In the questions that follow, we make a distinction between what might be termed 'continuous improvements/changes' in your firm's operating procedures and a 'sudden change' (e.g. due to a sudden increase in the price of inputs to production, an unexpected change in upper management or new legislation.) We are also testing the significance of this distinction.

2) Would you describe the change outlined above as a change happening over an extended time period (as part of a 'programme of change') or suddenly, a 'one off' event? Or was it a combination of the two (e.g. a sudden change that eventually led to a 'programme of change')?

Programme of change

☐

One-off

☐

Combination of 'programme' and 'one off'

☐

3) Could you briefly describe what the major stumbling blocks were during the implementation of the environmental/social activity or programme and how you went about overcoming them:

4a) Did your firm 'learn' from the experience (e.g. did the activity or programme trigger further changes or was the experience gained transferred to other departments or facilities)?

Yes ☐

No ☐

4b) If so, could you please outline how; if not, could you please describe why not:

IV) SOCIO-ECONOMIC AND ORGANISATIONAL CONTEXT OF 'GREEN INNOVATIONS'

We have listed some potential external and internal changes and activities that might be among the reasons for your firm's environmental/social *continuous improvements* or they might be responsible for triggering more *sudden improvements*. If you feel they influence both, continuous *and* sudden, please tick both relevant boxes.

Please indicate *how significant* you consider these changes to be in bringing about continuous and/or sudden improvements.

External/internal changes and activities	Significance in bringing about improvements							significant for continuous and/or sudden improvements	
	Insignificant				Significant			continuous	sudden
	1	2	3	4	5	6	7		
New technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New supply challenges (e.g. change in price of raw materials)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New regulation <i>nationally</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New regulation <i>EU</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New regulation <i>Internationally</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

External/internal changes and activities	Significance in bringing about improvements							significant for continuous and/or sudden improvements	
	Insignificant				Significant			continuous	sudden
	1	2	3	4	5	6	7		
Voluntary agreements With regulator	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Increased competition <i>nationally</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Increased competition <i>internationally</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inter-firm co-operation within the pharmaceutical industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Emergence of new industry niches	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New or shifting customer needs <i>nationally</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New or shifting customer needs <i>internationally</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shift in suppliers' needs/ values	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shift in distributors' needs/ values	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shift in shareholders' needs/values	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shift in financial service providers' needs/values	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shift in insurance companies' needs/values	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Increased pressures from Non-Governmental Organisations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

External/internal changes and activities	Significance in bringing about improvements							significant for continuous and/or sudden improvements	
	Insignificant					Significant		continuous	sudden
	1	2	3	4	5	6	7		
Increased pressures from local communities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Suggestions for improvements from employees	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Change of firm premises	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Change in upper management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Change in firm's organisational structure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Others, namely:									
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments

If you want to comment on any aspect of 'green innovations' or corporate environmental and social performance, please do so. We are particularly interested to know what barriers your firm has experienced in the past and what barriers it expects to encounter in the future process of improving and measuring its environmental and/or social performance.

Thank you very much for your participation.

APPENDIX 3 Eco-labelling Survey

Ecological product innovation in the Coatings Industry

I.) The nature of your firm

1.) Product range

- a.) Production in the coatings industry is categorised into different product sectors. For your firm, what volume of production falls into the sectors of industrial and decorative coatings? What are the percentage shares of these sectors in the total sales of your firm?

▪ **Industrial coatings:** _____ t _____ %

▪ **Decorative coatings:** _____ t _____ %

- a.) What percentage of your production of decorative coatings falls into the category of **DIY paints and varnishes**?

_____ %

2.) Export trade

- a.) What **percentage** of your total production of paints and varnishes is **sold outside the UK**?

_____ %

- b.) What are the **main export markets** your firm serves?

Europe ☐

North America ☐

Japan/South East Asia ☐

Other ☐ *please specify:*

3.)

- a.) Is your firm part of a **multinational company**?

Yes ☐ *please give name and locations of parent:*

No ☐ (*go to 4*)

b.) If 'yes', then please indicate, whether your corporate environmental strategy is defined by the parent company:

Yes ☐

No ☐

4.) Number of employees

- | | | | |
|----------------------------------|------------------------------------|--------------------------------------|--|
| <input type="checkbox"/> 1 – 19 | <input type="checkbox"/> 50 - 99 | <input type="checkbox"/> 250 – 499 | <input type="checkbox"/> 1,500 – 5,000 |
| <input type="checkbox"/> 20 – 49 | <input type="checkbox"/> 100 - 249 | <input type="checkbox"/> 500 – 1,499 | <input type="checkbox"/> > 5,000 |

5.) Yearly turnover: _____ £

6.) What percentage of your firm's turnover is spent on **R&D**? _____ %

II.) Environmental strategy of your firm

1.) Environmental Management

a.) Has your firm fully implemented the **Coatings Care** Programme of the British Coatings Federation?

Yes ☐ since: _____

No ☐

b.) Does your firm have an **environmental management system (EMS)** in place in any of its sites or organisational units? *For definitions, please refer to the glossary at the end of the enclosed letter.*

Yes ☐ since: _____

No ☐ (go to 2.)

c.) If 'yes', how many of your firm's sites have an EMS in place?
Please state number of sites with EMS and total number of sites.

Number (with EMS): _____ Total number: _____

d.) Is the EMS of your firm certified? *Please state type and year of first certification.*

Yes <input type="checkbox"/>	please specify: EMAS	<input type="checkbox"/>	since: _____
	ISO 14001	<input type="checkbox"/>	since: _____
	Other	<input type="checkbox"/>	since: _____

please specify: _____

No ☐

- 2.) Please indicate if your firm's **environmental policy includes** any of the following tools.
For definitions, please refer to the glossary at the end of the enclosed letter.

Environmental reporting ☐ since: _____

Environmental auditing ☐ since: _____

Environmental Impact Assessment (EIA) ☐ since: _____

Other ☐ since: _____

3.) Life Cycle Assessment (LCA)

- a.) Does your firm use Life Cycle methodologies to assess the environmental impact of its products?

For definitions, please refer to the glossary at the end of the enclosed letter.

Yes ☐ since: _____ No ☐ (go to 4.)

- b.) If 'yes', are the results used for changes in product design ('Design for Environment') or the development of new products?

Yes ☐ No ☐

- 4.) How would you assess the importance of the following **reasons for improving the environmental performance** of your firm?

	<i>extremely important</i>	<i>very important</i>	<i>important</i>	<i>less important</i>	<i>not important</i>
1. new technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. improving company's reputation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. new <i>national</i> regulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. new <i>international</i> regulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. increased competition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. shifting customers' preferences	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. pressures from local community	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Other, <i>please specify</i> :	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Looking at the above reasons again: what was the **single most important reason** of your firm for improving its environmental performance?

- 5.) The EU Directive 1999/13/EC includes the setting of emission limit values for **Volatile Organic Compounds** (VOCs). What has your firm done or what is it planning to do in the future to fulfil requirements set by the directive or equivalent national legislation?

☐ invest in **abatement technology**

☐ **Other**, please specify:

☐ change **production process**

☐ increase production of **VOC-free paints/coatings**

III.) Product policy

1.) 'Green' products

- a.) Does your firm's product range include any products of the following?

☐ Water-based/VOC-free paints ☐ Powder coatings ☐ High solids

- b.) What is the share of these products in total production? _____ %

- c.) Does your firm intend to develop new products in the above categories or is it planning to step up production?

Yes ☐

No ☐

2.) 'Green' consumerism

- a.) How do you estimate future demand for 'green' products?

significant increase *moderate increase* *not changing* *moderate decline* *significant decline*

☐ ☐ ☐ ☐ ☐

- b.) What is your estimation based on?

development of sales over the years ☐ market research studies ☐

other ☐ please specify:

3.) Eco-labelling

a.) Did you know that indoor paints and varnishes is one product group in the **European Union's Eco-labelling scheme**?

Yes ☐ (*please go to c.*) No ☐ (*please go to b.*)

b.) If 'no', do you think your firm would be interested in using the Eco-label as part of its marketing strategy, even if this would imply extra costs?

Yes ☐ (*please go to end of survey*) No ☐ (*please go to end of survey*)

c.) If 'yes', have you ever applied for the EU eco-label or are you planning to do so in the future?

Yes ☐ (*please go to e.*) No ☐ (*please go to d.*)

d.) What were the **reasons** for your firm's decision **not to apply** for the EU Eco-label?

- ☐ The Eco-label relevant **products** only play a minor part in the production of our company.
- ☐ The **criteria** of the Eco-label are not consistent with available technology.
- ☐ The benefits of obtaining the Eco-label are not proportional to the **expense**/effort.
- ☐ The **application procedure** is too lengthy and expensive.
- ☐ The **communication** with the competent body (DETR in the UK)
- ☐ **Other**, *please specify*:

e.) Have any of your firm's products been awarded with the EU Eco-label?

Yes ☐ (*please go to f.*) No ☐ (*please go to end of survey*)

f.) How many of your firm's products have qualified for the EU eco-label? What share do these products have in your total turnover?

Number: _____

Percentage (of total turnover): _____

g.) How would you assess the importance of the following reasons in your company's decision to use the Eco-label?

	<i>Very High</i>	<i>high</i>	<i>moderate</i>	<i>low</i>	<i>very low</i>
1. play a part in protecting the environment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. satisfy customers expectations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. improve the chances of our products in the market.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. gain competitive advantages by early use of the label.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. respond to the use of the label by our competitors.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. enhance the image of the company amongst customers and business partners.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. meet the demands of retail trade.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Other, <i>please specify</i> :	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Looking at the above reasons again: what was the **single most important reason** for your company deciding to use the EU Eco-label for its products? *Please enter number.*

h.) How important were the following effects with regards your use of the EU Eco-label?

	<i>Very High</i>	<i>high</i>	<i>moderate</i>	<i>low</i>	<i>very low</i>
1. Our market position compared with our competitors has been improved.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The image of our firm in the public eye has been improved.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Using the EU Eco-label has noticeably increased sales of labelled products.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Marking our products with the EU Eco-label has been positively welcomed by our business partners.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Use of the Eco-label has been positively welcomed by our employees. ☐ ☐ ☐ ☐ ☐

continued on page 6

6. Other, please specify: ☐ ☐ ☐ ☐ ☐

- ☐ Looking at the above effects again: what was **the single most important effect** your company experienced by using the Eco-label? *Please enter number.*

Thank you very much for your effort!

Comments

If you have any comments on eco-labelling, eco-innovations or other relevant issues, please feel free to express them here.

Feedback

If you wish, we can provide you with the results of the survey and the project, which are expected in September 2001.

Company: _____

Address: _____

Your name: _____ Your position: _____

Telephone: _____ E-mail: _____

- ☐ Yes, I would like a summary report of survey results